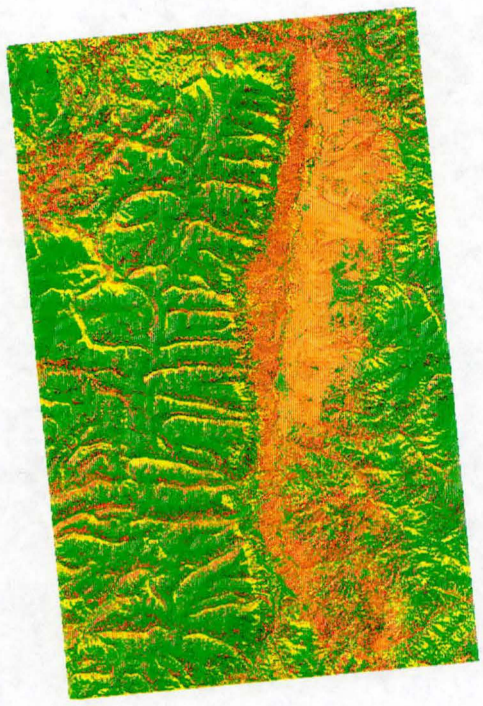
03-JV-11222048-261

FINAL REPORT

FLAMMAP AND MINIMUM TRAVEL TIME MODELING FOR THE BITTERROOT ECOSYSTEM MANAGEMENT RESEARCH PROJECT



Submitted to:

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Agreement Number: 03-JV-11222048-261

By:

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March 30, 2004

Thesis/
Reports
Stratton,
R.

Deliverables

1. Attend BEMRP meetings with Forest Service and University of Montana personnel.

Status: Completed (June 2003; Jan. 2004; Feb. 2004; March 2004)

Narrative: On March 26, modeling results were delivered to managers and collaborating researchers and technicians.

2. Develop historical weather data necessary for the modeling environment (Fire Family Plus).

Status: Completed (December 2003)

Narrative: Weather information from three RAWS stations were used in Fire Family Plus to develop the weather, fuel moisture, and wind information requisite for modeling in FlamMap. Data included 1-, 10-, 100-hr, live herbaceous, and live woody fuel moisture, min. and max. temperature, min. and max. relative humidity, 20-ft wind speed, and wind direction.

3. Compile, develop, and/or become familiar with the data layers required for use in FARSITE, FlamMap, and the Minimum Travel Time (MTT).

Status: Completed: (July 2003)

Narrative: Exploratory modeling was done on 3 candidate FARSITE datasets for the Bitterroot Front Range (i.e., existing FARSITE data (pre-2000); MAGSIM database; fires 2003 database). The fires 2003 database (Fire Lab) was used in the final product due to it being the most current and tailored for modeling fire growth.

4. Use the above models to map fire hazard and identify optimal fuel treatment patterns to mitigate fire spread into wildland-urban interface areas.

Status: Completed: (March 2004)

Narrative: FlamMap was used to produced fire growth projections for every pixel on the landscape at 30-meter resolution. Output from the 97^{th}+ percentile run included the elliptical dimension of the ellipse (a, b, c) and the max spread rate. These output were used by the MTT algorithm to produce MTT vectors and influence pathways (raster). A series of treatments in and around these high influence pathways may result in a more optimal way to mitigate the spread and intensity of a large fire.

5. Research reporting and presentation of model(s) methodology, output, and results.

Status: Completed: (Feb.2004; March 2004)

Narrative: Preliminary results were presented in the Feb. 2004 meeting. A short narrative and final model outputs were delivered to managers and modelers on March 26, 2004.

TASKS

1. **Attend BEMRP meetings with Forest Service and University of Montana personnel.**
2. Develop historical weather data necessary for the modeling environment (Fire Family Plus).
3. Compile, develop, and/or become familiar with the data layers required for use in FARSITE, FlamMap, and the Minimum Travel Time.
4. Use the above models to map fire hazard and identify optimal fuel treatment patterns to mitigate fire spread into wildland-urban interface areas.
5. Research reporting and presentation of model(s) methodology, output, and results.

BEMRP Landscape Project

Agenda – Modelers Meeting – Friday 26 March 2004

Each of 4 modeling groups will present the status of their Bitterroot Front models, provide an overview of how their modeling tool works, and answer questions posed by managers and other modelers. Managers will guide modelers with format needs of final map and planning products.

9:00 – Introductions

9:05 – SIMPPLLE – Jimmie Chew, Bob Pfister, Martin Twer

9:45 – MTT – Minimum Travel Time – Rick Stratton

10:25 – BREAK

10:35 – A Protocol for Identifying Fire Benefits and Risks – A pre-optimization tool – Tonya Opperman, Anne Black

11:15 – MAGIS - Kevin Hyde

11:45 – Closing discussion

12:00 – Adjourn

Date: 23 March 2004 kh

BEMRP Bitterroot Front Analysis Meeting
6/6/03

Attendance:

Greg Jones	RMRS, Msla	Jeannie Higgins	Bitterroot NF (Stevi RD)
Rick Stratton	SEM, Msla	Jim Chew	RMRS (Msla)
Kevin Hyde	RMRS Msla	Sue Heald	Bitterroot NF, SO
Bob Pfister	UM	Martin Twer	UM
Don Helmbrecht	UM		

The objective of the meeting was to develop a plan for how to proceed with the analysis of the Bitterroot Front area. We decided to approach this by identifying specific tasks, the date when the tasks are to be completed, and the person(s) responsible for the tasks. We concentrated on those tasks that require interactions among folks. Tasks internal to individual models are not listed. The individual modelers are responsible for getting their models ready to run for the schedule outlined below. Some tasks build on others, so it is important to complete tasks on schedule for the project to be completed on schedule. The person identified as lead is responsible for written documentation for each task. The tasks and associated information follow:

Date	Task	Person(s)
6/30	(1) Complete the vegetation coverage for the Bitterroot Front for use in SIMPPLLE and MAGIS	
	(a) Compare the "BEMRP" veg coverage with the BNF data and make appropriate updates	Jim Chew (Lead) Jim Fears Kim Johnson Martin Twer
	(b) Obtain treatment history	Jim Chew (Lead) Jim Fears
	(c) History of insect and disease disturbances (Jim get fro RO, reality check by Kim Johnson)	Jim Chew (Lead) Kim Johnson
6/13	(2) Obtain the available FARSITE data coverages	Rick Stratton (Lead) Tonja Opperman Ann Black
7/15	(3) Compare the FARSITE data coverages with the vegetation coverage developed for SIMPPLLE and MAGIS and evaluate whether additional work is need to make them compatible	Rick Stratton (Lead) Martin Twer
8/15	(4) Complete the treatment logic and disturbance logic for SIMPPLLE	Jim Chew (Lead) Martin Twer Kim Johnson

8/31	(5) Develop standing volumes for the vegetative states used in SIMPPLLE and MAGIS (a) Compare current first cut estimates with FIA plots (b) Revise volumes as necessary	Kevin Hyde (Lead) Martin Twer Bob Pfister Kim Johnson
9/30	(6) Complete model runs for the current conditions and projecting the current conditions into the future assuming no treatments using Flammap, Min. travel time, and SIMPPLLE	Rick Stratton (Lead) Martin Twer (Lead) Jim Chew
10/31	(7) Compare results from step (6) and develop criteria for treatment scenarios (a) Scenarios may or may not include treatments in the Forest's 5-year plan (b) At least one scenario would involve the amount of treatments needed to fully achieve desired conditions (c) Include long-term and short-term results	All (Lead to be determined)
12/15	(8) Develop Scenarios	All (Lead to be determined)
1/31	(9) Simulate effects of scenarios for landscape as a whole and specific locations	All (Lead to be determined)
2/28	(10) Complete Proposed Action for fuel treatment/restoration project	All (Lead to be determined)
	(11) Document methodology (a) Compare and interpret results (b) What was unique roles for the individual models	Don Helmbrecht Others

Notes by Greg Jones
6/13/03

Minutes: BEMRP Bitterroot Front Analysis Meeting

Date: 16 January 2004 kh

Programmer/Researcher Meeting held at Forestry Sciences Lab

In attendance:		
	Kevin Hyde	RMRS – MAGIS
	Greg Jones	RMRS – MAGIS
	Jim Chew	RMRS – SIMPPLLE
	Chris Stalling	RMRS – SIMPPLLE
	Becky McFarland	RMRS – SIMPPLLE
	Anne Black	ALWRI
	Edward Butler	UM– MAGIS
	Rick Stratton	SEM – MTT (FARSITE)
	Bob Pfister	UM
	Martin Twer	UM

Meeting was called to review progress of task and timeline assignments set at the 6 June 2003 meeting held at Stevensville RD office.

Task Review:

1. Complete vegetation coverage for MAGIS and SIMPPLLE (MAGSIM)

   Status:
   - MAGSIM Veg layer, rev. 062102, updated to include fire since 2000 and saved as new coverage, rev. 102303
   - Efforts by SIMPPLLE (Chew) to obtain corrected geospatial insect and disease data were unsuccessful – these data were not available
   - Kim Johnson (BNF) reports the GIS is substantially up-to-date for recent treatments on Forest. Treatment acreage over last few years is limited and should not affect results.

   Comments:
   - MAGSIM vegetation layer comes from R-1 dataset, created per R-1 guidelines and classified as used in SIMPPLLE
   - Chew does not believe it is feasible at this point to complete the insect and disease updates in time for this modeling effort.
   - The decision was reached to abandon further efforts to revise the vegetation coverage for insect and disease disturbances
   - Fire revised layer to be transferred to Twer and Stratton by Hyde

2. Obtain available Minimum Travel Time (MTT) data coverages (MTT uses FARSITE to analyze spread locations from multiple possible fires)

   Status:
   - Initial Vegetation layer proposed for MTT modeling was created from LANDSAT images acquired during the year 2003 fire season and classified for fire behavior modeling with vegetation classification incompatible with MAGSIM standards

- Other necessary data are in place

Comments:

- Findings of the comparison made in Task 3 led to conclusion that we should attempt to crosswalk MAGSIM veg cov to classifications required for MTT – detail follow in discussion of Task 3

3. Compare MTT vegetation coverage with MAGSIM veg cov

Status:

- Hyde and Twer presented preliminary results of veg cov comparison
- Comparison highlighted need to use identical data sets for all analysis
- This led to discussion of need to define crosswalk of MAGSIM veg attributes to fuel model classifications that can be used in MTT model

Comments:

- Stratton will discuss feasibility and logic of crosswalk ASAP with Don Long
- Final cross walk logic need to be reviewed and approved by SIMPPLLE and MAGIS teams
- Once feasibility confirmed and rules are defined, Hyde and Black will co-ordinate to modify veg cov GIS

4. Complete treatment logic and disturbance logic for SIMPPLLE

Status:

- Pending

Comments:

- Pfister, Twer, Chew, and Stalling agreed to set meeting for next week

5. Develop standing volumes for vegetative states used in MAGSIM

Status:

- Existing volumes in MAGIS were reviewed, revised, and confirmedby Kim Johnson and Hyde
- MAGIS tables to be updated by Hyde
- FVS/FIA volumes have been classified per MAGSIM attributes and can now be compared
- Comparison to be made by Twer and Hyde

Comments:

6. Complete model runs for current conditions and projection into future assuming no management actions

Status:

- First SIMPPLLE runs were conducted by Twer during Summer 2003 using MAGSIM veg cov rev. 062102
- First MTT runs were conducted using Fire Science veg cov from summer 2003.
- Initial MAGIS model in primary build phase, initial import of rev. 102303 was provisionally successful

Comments:

- Runs need to be redone and advanced using datasets that are the products of Tasks 3 and 4

Task 7-11 below pending results of tasks listed above, results of 20 Jan BEMRP meeting, and

meeting with Johnson to define treatment activities BNF propose to use to reduce fuels

7. Compare results from (6) and develop criteria for treatment scenarios
8. Develop Scenarios
9. Simulate effects of scenarios for landscape as a whole and specific locations
10. Complete Proposed Action for fuel treatment/restoration project
11. Document methodology: (a) Compare and interpret results; (b) What was unique roles for the individual models

Summary of decisions made:

- Abandon insect and disease update to MAGSIM vegetative coverage
- Use current revision of MAGSIM veg coverage (102303) for modeling
- Determine feasibility and timeline to crosswalk MAGSIM veg cov to fuel model classification required for MTT runs
- No changes in successional pathways will be made in SIMPPLLE logic
- We will meet again in 4 weeks – 13 February, 9:00 AM.

Summary of actions:

1. Finalize vegetation coverage for MMT runs:
   - ? Determine feasibility of MAGSIM/MMT fuel model crosswalk; define rule-set (Stratton)
   - ? Review and approve crosswalk rule-set (Stratton, Chew, Jones)
   - ? Coordinate logistic of GIS update to execute rule-set (Stratton, Hyde, Black)

2. Resolve disturbance and treatment logic
   - ? Chew and Pfister to meet ASAP
   - ? Meet with BNF manager(s) to review proposed menu of treatment activities; what managers want to treat for; how do they do they want to include wilderness areas in modeling? (Hyde, Johnson, Stalling, Jones)

3. Resolve fire spread modeling decisions
   - ? Stratton and Chew to confer ASAP

4. Complete volume comparisons – MAGIS with FVS/FIA
   - ? Twer and Hyde to begin week of 1/20.

5. Determine timing preferences and needs of BEMRP/BNF managers
   - ? Discuss during 20 Jan meeting of BEMRP during project progress report (Jones, Hyde)

6. Clarify first deliverable product to BNF – fire spread maps (Jones, Hyde, Higgins)

BEMRP Landscape Project

MINUTES from 19 February 2004 Meeting

In Attendance:		
	Greg Jones	FSL
	Rick Stratton	SEM – Fire Lab
	Bob Pfister	UM
	Mick Harrington	Fire Lab
	Helen Smith	Fire Lab
	Ed Mathews	Fire Lab
	Sue Heald	BNF
	Kevin Ryan	Fire Lab
	Jeanne Higgins	BNF
	Neil Moisey	UM
	Kim Johnson	BNF
	Kevin Hyde	FSL
	Robert Nelson	UM
	Kari Gunderson	ALWRI
	Yvette Ortega	FSL
	Ward McCaughey	FSL
	Dave Calkin	FSL
	Martin Twer	UM

(NOTE: List of agreed upon actions is at the end of this document)

Status of BEMRP Landscape Project –

Greg Jones passed out copies of the BEMRP Landscape Project Proposal indicating this project will be a central theme to BEMRP activities. Project objectives and timelines were reviewed raising two questions: What revision of Phase 1 &2 timing is required given that progress on these is running behind? What research questions should drive the modeling? These questions were addressed as the meeting proceeded.

Review of Analysis of Social Values (Kari Gunderson) –

Kari distributed a one-page summary of the social values study plan. Information is being gathered from Bitterroot Valley residents to use maps to identify places important to them along the Bitterroot Front, e.g. areas for recreation, hunting, outfitting, mining, and gathering firewood. Kari is working with Robert Nelson to develop a method to transfer the sketched map data to a GIS layer for use in MAGIS and SIMPPLLE. Modeling use requires decisions on how to quantify socially-valued areas and appropriate methods to monitor and track impacts of fuel reduction treatments upon areas of value. How will the boundaries be structured and displayed? Are these areas to be considered, "Social Values at Risk?" If so, how are levels of risk to be defined and determined? Map products will be published and are expected to be useful as managers consider potential impacts of activities upon social values.

Review of Modeling Status – Phase 1 –

1. SIMPPLLE (Martin Twer)

Martin presented a map of preliminary SIMPPLLE modeling results showing the probabilities of fire along the Bitterroot Front. Model probabilities are based upon many factors including fire start

history, empirical fire behavior data, adjacency effects, fire spread expectations, vegetation conditions, landscape morphology.

2. MTT (Rick Stratton)

Rick presented similar maps from MTT runs. He emphasized the importance of treatment matrices as we plan fuel reduction strategies – the bigger the matrix, the better. Also, carefully consider the significance of the BNF fire history maps. Rick indicated the need to meet with FMO's and other forest managers to calibrate MTT model results using direct, land-based, "gut" knowledge. He cautioned that when interpreting MTT results, "Do not pick your favorite line." Recognize fire runs as indicators of general paths.

Discussion –

Kevin Ryan expressed that we need further discussion about derivation of SIMPPLLE probabilities and how they are derived. What are the differences between the MTT approach to fire spread modeling and SIMPPLLE? How are we accounting for these differences? Also, consider differences between vegetation data sources as explained by Kevin Hyde. Rick Stratton stated that the biggest data difference is in classification of barren or rock – areas that are critical given their effects on fire behavior.

Are we modeling the right threat – assuming strong winds from the west driving fire down from the divide? Should we not also model assuming spread from small patches at the foot of the range, moving up the divide?

Jeannie Higgins' first impression is that the images from both models appear helpful and that the recognized differences should not be a major source of worry. Sue Heald expressed that her vision of Phase II is that the modelers and the managers sit together to interpret the results of the simulated outcomes. Modeling could help us identify where we can employ Wildland Fire Use. How can we develop treatments that allow fire use as a back-up?

Mick Harrington emphasized that treatments must be very large and that the "Treatment Matrix" is the key.

Sue Heald asked how we can connect with past treatment history

3. **MAGIS (Kevin Hyde)**

Kevin presented a summary of the Forest Health Restoration Act of 2003 (FHRA) and the guiding language that direct where fuel reduction treatments should be directed per the law and how this language might influence the build and run of MAGIS scenarios. He presented a wall map of the Bitterroot Front which displays WUI buffers as defined by structure location. WUI buffer considers proximity of potential fire breaks, steep slopes, and forests classed in Fire Regime Condition Class III (FRCC).

Discussion: Kevin Ryan asked for clarification of source of FRCC mapping. Sue Heald stated that we can opt out of the FRHA guidelines but that this might limit available fuel treatment dollars. WUI definition is a difficult moving target over which state governors have substantial say. How do we balance WUI with comprehensive landscape knowledge and the recognition of the need to treat outside the WUI "donut"? Jeannie stated that the most substantial impact of the FRHA is in context of Forest Plan and the social acceptability of the scale at which it appears we need to treat.

We proceed with this vision: Take the model results and identify priority areas, the potentially important treatment sites. It was agreed that model outputs presented this day are converging on managers needs. The outputs will be critically assessed by managers and modelers at the next modelers meeting (Friday, 26 March).

The next steps for modeling runs were discussed leading to action list points at the end of these notes.

Research Opportunities and Needs Associated with Fuel Treatments – (Greg Jones)

As we move from modeling to treatment plans we face these questions: What vegetation to treat? What treatments methods to use? Researchers expressed reservations that very little could be done until specific treatment sites are located. Certainly, pre-treatment assessments are not possible, that it is unlikely we can begin any sort of field work this summer.

Information Needs?

- What information needs are currently identified?
- The group was referred back to the document produced on 10 December 2002, "Research Questions." It was generally agreed that the questions as stated represent the major issues.
- The issues identified – water, soils, sediment, fish, wildlife, weeds, etc. – need development
- One-to-one partnering of researchers with managers will be beneficial now.
- How can these discussions drive the selection of both treatment and research areas?
- Are literature reviews that support effects of fuel reduction studies complete and current?

Issues raised about research structure?

- At what scales do we work?
- Recognize the questions we can approach in the field versus those which can only be modeled. For example, we cannot realistically conduct on-the-ground tests of the effectiveness of fuel reduction activities. We must, however, substantially document all our work, providing future managers and researcher with the information that my allow them to answer questions of effectiveness as fires impact the Bitterroot Front in the future.

Concerning Theory of Fuel Reduction Treatments

- We start with two assumptions:
    - Fire behavior can be changed with treatments
    - Treatment locations alter fire path, intensity, and spread rates
- We recognize that models are hypotheses of the effects of fuel treatments
- Models can drive treatment designs and help guide and defend management decisions
- Treatment objectives may be in conflict with other management objectives, e.g. ecological, recreation, social
- We need to understand
    - How best to place the treatments?
    - What are the effects of the treatments?
- What are the treatments we are going to use?
- A critical question?
    - Is it feasible to treat enough acres fast enough to make a difference?
    - Perhaps not. The answers to this question may be the most significant findings of our efforts.

Agreed Upon Actions

Phase 1 Modeling and Treatment Planning:

General objectives within next 60 days:

1. Complete fire and planning models – SIMPPLLE, MTT, MAGIS
2. Inventory and interpret current and pending treatment projects
3. Initiate interactions between researchers and managers to better define the information needs this research could address, and well as other considerations for the project.

a. Wildlife – Yvette Ortega
b. Silviculture –Mick Harrington
c. Water and soil – Kevin Hyde
d. Human Dimensions – Kerry Gunderson

4. Encourage researcher to researcher conversations

Modeler Tasks:

1. **MTT/SIMPPLLE (Martin Twer, Robert Pfister, and Rick Stratton)**: Create menu of display options for SIMPPLLE and MTT results. Managers will review these prior to final modeling runs.

   DUE: 3/26 – Next Modelers meeting with Managers

2. **MAGIS (Kevin Hyde, Greg Jones, Janet Sullivan):**
   a. Resolve FRCC map source for use in this project. Confer with Kevin Ryan and Don Long at Fire Sciences Lab to make this determination.
   b. Complete GIS build of layers which apply to FRHA.
   c. Complete MAGIS model build with input from Kim Johnson for management activity rules to use to assign treatments.
   d. Confer with Kim Johnson, BNF to identify past treatment history and integrate this into modeling GIS
   e. Complete preliminary runs for meeting

   DUE: 3/26 – Next Modelers meeting with Managers

3. **Model Comparison Study Plan (Greg Jones, Kevin Hyde, Kevin Ryan, Jim Chew, Bob Pfister):**
   a. Resolve questions of how SIMPPLLE and MTT modeling efforts will interact. How do we compare the modeling tools, the modeled outputs, and the interaction of the outputs on the landscape?
   b. Complete draft study plan and circulate to the lead researchers for review, edit, and amendment.

   DUE: 5/6 – Next BEMRP group meeting

Next Meetings:

- 26 March – Friday, 9 AM to Noon – Forestry Sciences Lab
  - BNF Managers and Modelers review simulation results and demonstration MAGIS scheduling options
  - Define format of final fire simulation runs to be completed prior to next full BEMRP Meeting
- 5 May – Wednesday, 9 AM to 5 PM – Forestry Sciences Lab
  - Review results of researcher-to-researcher, manager-to researcher conversations
  - Review final simulation results, candidate treatment locations, specific treatment agendas
  - Day to be scheduled with specific time blocks – not everyone needs to be present for the entire day

Prepared by Kevin Hyde
10 March 2004

TASKS

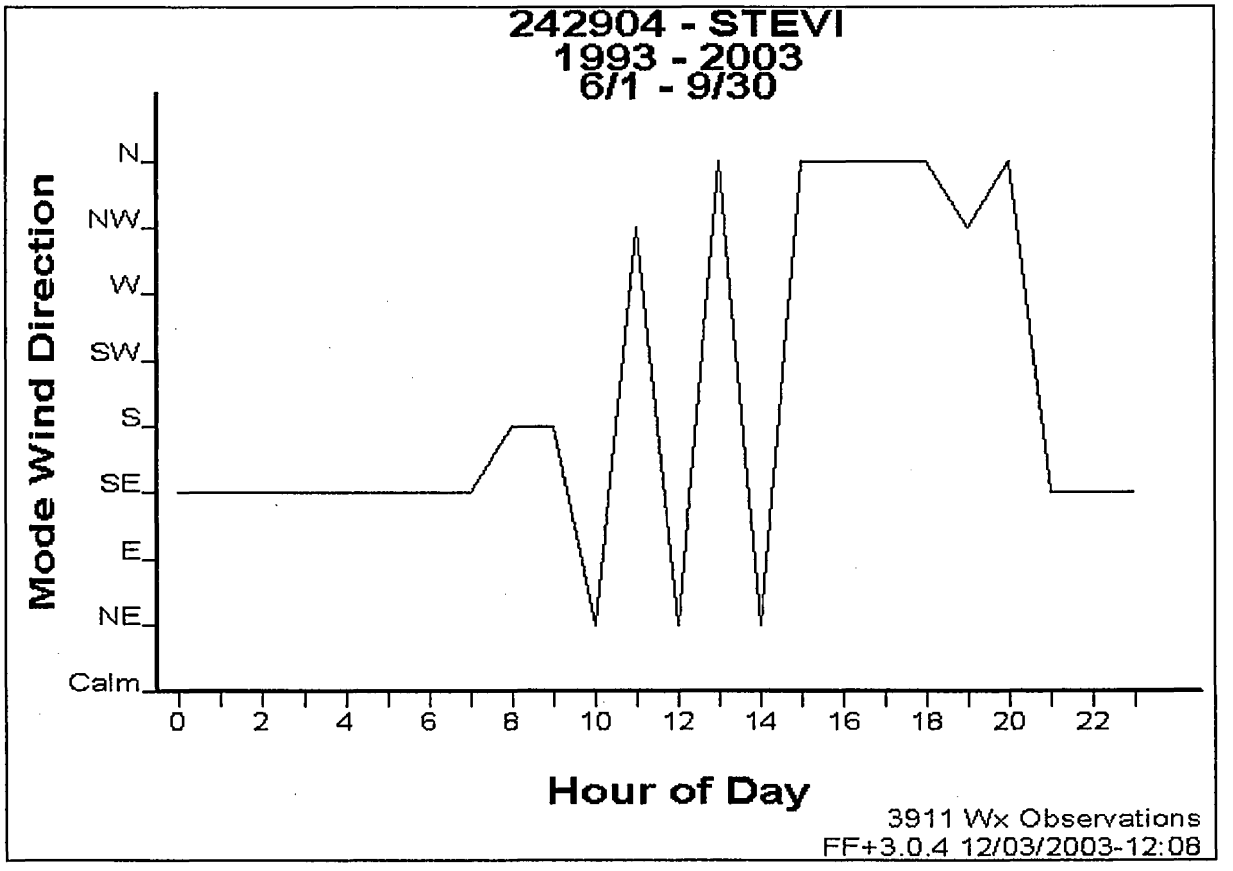
1. Attend BEMRP meetings with Forest Service and University of Montana personnel.
2. **Develop historical weather data necessary for the modeling environment (Fire Family Plus).**
3. Compile, develop, and/or become familiar with the data layers required for use in FARSITE, FlamMap, and the Minimum Travel Time.
4. Use the above models to map fire hazard and identify optimal fuel treatment patterns to mitigate fire spread into wildland-urban interface areas.
5. Research reporting and presentation of model(s) methodology, output, and results.

95th	Steven (3360)	Smith Ck. (5650)	Deer Mtn (7283)	FlamMap
	(11 yrs)	(3 yrs)	(50 yrs)	
	Stevensville	10 mi SW Steve	7 mi E of Darby	
1-hr (%)	5	4	5	4
10-hr (%)	5	4	4	5
100-hr (%)	11	6	7	7
Live Herb. (%)*	42	30	42	50
Live Wood. (%)*	95	51	73	90
Temp. Min.(°F)	59	65	60	
Temp. Max. (°F)	96	88	81	
RH Min. (°F)	18	14	18	
RH Max. (°F)	75	33	38	
20-ft Wind Spd. (mph)	9/13*	7/11*	17/22*	22
Wind Direction(°)**	N/NW-NE	NW/SE	NW/W/N	270

Data obtained from Fire Family Plus/Weather/Sesasonal Reports/*Severity Summary*

*Adjusted from the Seasonal *Severity Report* to account for wind gusts (NOAA 2003).

**From windspeed vs direction report (Weather/Winds)


242904 - STEVI
1993 - 2003
6/1 - 9/30
Mode Wind Direction
N
NW
W
SW
S
SE
E
NE
Calm
0
2
4
6
8
10
12
14
16
18
20
22
Hour of Day
3911 Wx Observations
FF+3.0.4 12/03/2003-12:08

FireFamily Plus Diurnal Report
Wind Direction
Station: 242904 - STEVI

Time Frame: 6/1 - 9/30
Data Years: 1993 - 2003

Mode Values by Hour of Day by Date

Date	Hour 0	1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20	21	22	23		
6/ 1		4	3	3	7	1	3	1	8	5	7	1	1
	8		7	7	8	1	8	8	1	8	1		
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6/ 4	3		8	7	4	3	3	2	7	1	7	7	4
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6/25	3	3	1	2	2	6	2	8	7	8	7	1	1
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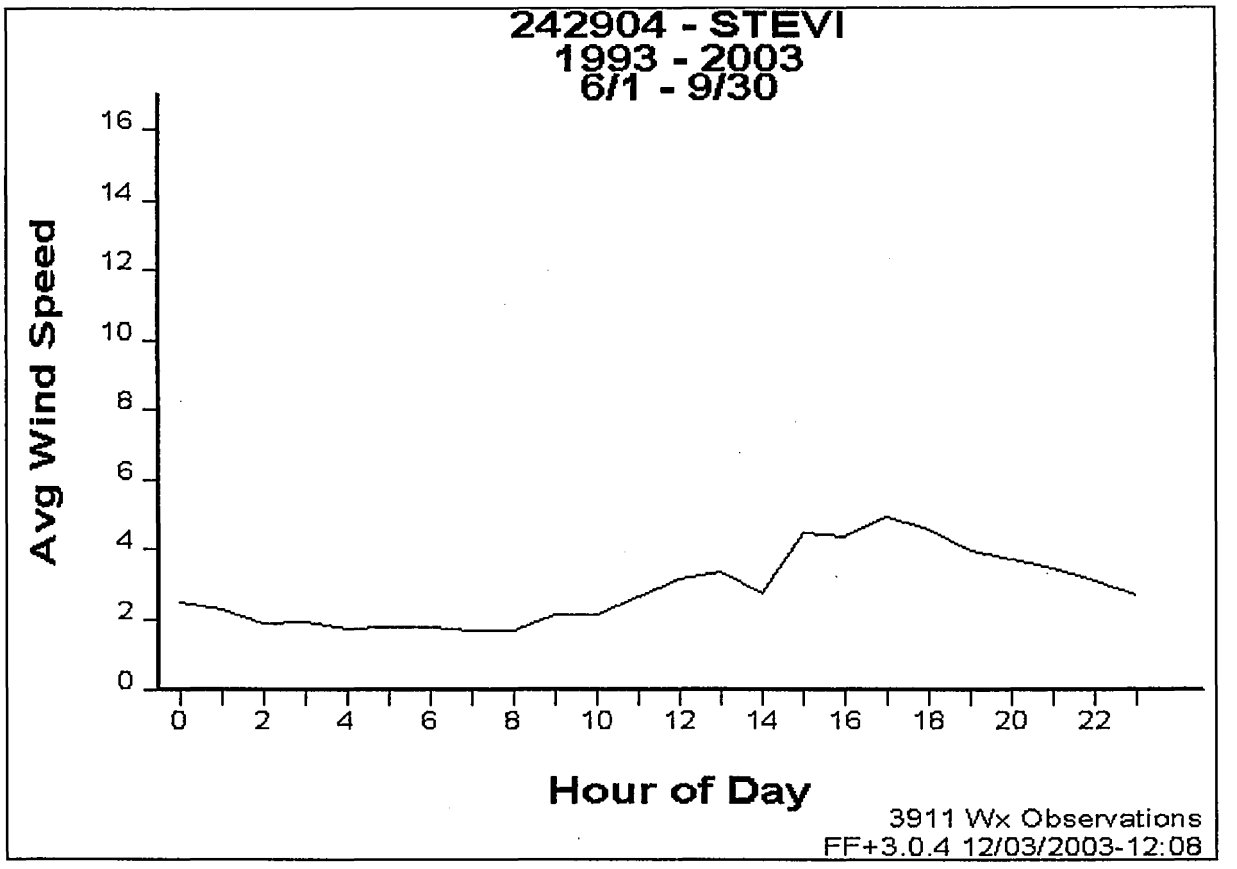
6/26	5	4	5	4	7	3	1	4	6	8	8	1	6
7		7	8	8	1	1	2	4	4	7			
6/27	4	3	2	2	6	7	5	5	4	6	4	1	8
7		1	8	4	8	2	4	3	2	3			
6/28	4	1	3	3	8	1	6	3	8	3	5	4	4
8		5	7	8	7	7	7	8	1	3			
6/29	3	1	2	6	1	1	7	1	1	1	2	6	5
4		7	8	3	6	8	7	6	3	3			
6/30	3	8	4	3	1	7	2	8	8	8	2	7	1
7		8	7	6	6	6	7	7	5	1			
7/ 1	2	4	1	2	1	5	4	7	3	8	7	2	6
7		6	6	6	6	7	7	6	4	1			
7/ 2	3	1	6	3	4	2	4	1	7	8	6	4	7
7		1	8	8	8	8	7	7	6	2			
7/ 3	5	5	2	4	8	2	7	3	4	3	1	8	1
7	1	8	8	8	1		6	1	2	2			
7/ 4	5	5	2	3	2	5	4	6	1	1	1	2	8
1		8	8	8	7	8	8	1	4	2			
7/ 5	1	4	3	6	8	8	3	1	8	8	8	8	7
8		8	5	8	8	5	8	7	8	1			
7/ 6	2	4	6	3	2	2	5	3	7	8	1	2	1
1		7	6	7	8	8	7	5	1	4			
7/ 7	4	6	2	4	4	8	1	4	6	3	1	1	8
8		8	3	2	7	2		5	3	3			
7/ 8	4	4	6	3	4	6	6	4	6	8	5	4	6
2		3	6	7	7	7			1	8			
7/ 9	3	3	3	2	1	7	2	4	5	4	1	8	7
8		8	7	3	7	8	8	1	4	4			
7/10	4	5	3	2	6	3	3	6	3	1	8	8	7
0		7	6	8	7	5	8	7	7	4			
7/11	3	7	3	4	6	3	4	1	7	7	8	7	8
1		7	7	1	8	1	8	2	5	3			
7/12	3	3	4	3	4	4	3	1	8	8	7	8	8
1		3	8	7	2	7	1	2	8	5			
7/13	5	4	6	6	3	3	8	3	1	4	4	1	7
1		8	8	6	8	2	5	5	3	7			
7/14	1	8	5	2	5	4	7	3	5	4	7	7	8
7		8	3	8	6	7	6	7	7	1			
7/15	3	5	1	5	5	1	4	6	3	5	3	2	8
7		7	8	2	8	6	5	5	3	5			
7/16	2	6	3	8	2	3	3	4	4	4	4	4	1
8		7	8	8	8	2	5	5	7	3			
7/17	6	3	6	8	1	5	5	3	4	3	3	6	7
8		7	8	7	7	2	7	5	3	5			
7/18	3	2	2	5	1	3	1	2	1	5	7	2	8
8		7	8	8	2	4	4	3	3	5			
7/19	4	5	5		3	2	7	3	6	7	4	6	3
1		1	8	7	6	4	4	6	6	3			
7/20	3	1	1	4	7	5	3	4	6	7	7	8	5
8		2	8	8	6	1	6	4	3	3			
7/21	3	3	7	3	2	6	4	7	1	7	1	8	7
0		2	7	4	8	8	8	8	6	8			
7/22	7	7	7	7	8	8	8	1	7	4	7	7	6
8		7	6	7	8	8	8	1	3	4			
7/23	4	3	3	2		3	4	5	4	4	6	4	1
7		7	8	4	1	1	5	4	6	5			
7/24	1	5	3	1	2	1	6	5	2	7	4	7	2
7		7	7	7	1	4	4	4	3	3			
7/25	3	3	3	3	5	2	6	2	4	5	6	2	5
0		7	7	1	1	1	1	4	5	5			
7/26	5	4	5	4	6	5	6	5	8	8	7	7	5
7		3	7	7	6	6	6	7	2	3			
7/27	3	3	2	1	3	3	8	3	2	8	6	1	6

7		6	6	6	6	6	6	6	3	7			
7/28	4	6	5	3	3	4	5	4	3	3	5	4	5
0		5	6	6	5	6	2	7	1	3			
7/29	2	1	4	3	7	5	6	6	6	5	6	6	5
0		8	2	6	5	6	6	4	6	1			
7/30	3	4	6	3	3	1	6	5	2	7	5	6	7
4		5	6	5	6	7	6	6	6	4			
7/31	5	2	4	8	2	3	6	6	6	3	6	6	5
0		6	6	6	6	7	7	7	2	4			
8/ 1	3	2	4	4	8	4	3	8	2	7	1	6	8
7		7	7	7	8	8	8	5	3	5			
8/ 2	4	4	1	8	4	3	4	3	5	1	4	1	8
3		1	6	6	7	7	7	8	2	1			
8/ 3	5	8	4	4	4	4	4	2	1	8	8	2	1
3		8	8	7	7	7	7	8	3	1			
8/ 4	3	8	7	2	8	3	2	6	4	6	2	8	
8		8	8	8	1	0	6	7	4	5			
8/ 5	3	2	4	5	5	1	2	8	7	4	8	7	1
0	1	8	8	2	8	8	8	1	8	8			
8/ 6	1	8	3	8	2	5	3	3	8	1		1	1
8		0	8	7	8	7	8	1	1	5			
8/ 7	1	5	4	3	2	1	3	5	4	3	1	7	8
8		8	7	8	7	6	6	5	6	4			
8/ 8	3	3	3	2	3	5	3	7	1	7	4	3	2
6		3	5	1	3	4	3	5	3	3			
8/ 9	1	2	3	1	6	7	3	2	1	4	4	4	5
0		3	3	6	7	4	1	3	3	5			
8/10	4	6	3	7	4	1	2	4	1	8	5	3	6
1		5	6	6	5	1	6	5	4	3			
8/11	3	1	3	6	4	1	3	1	4	5	4	1	1
0		6	6	6	6	8	1	2	3	2			
8/12	3	7	5	4	5	7	3	5	8	3	2	3	2
1		2	4	1	6	6	6	6	7	3			
8/13	3	3	6	4	7	6	8	1	2	7	3	3	3
8		4	6	6	5	6	6	3	2	3			
8/14	3	3	4	3	3	3	1	1	8	6	2	1	8
6		7	1	6	5	6	6	7	8	1			
8/15	7	4	8	3	4	3	3	2	3	4	1	7	3
0		6	6	6	7	6	6	4	4	3			
8/16	4		1	8	4	6	3	4	5	6	1	7	6
1		8	8	8	8	8	8	8	3	3			
8/17	8	3	5	4	3	4	5	7	1	8	1	1	6
8		7	2	8	1	8	8	3	3	3			
8/18	4	2				5	6	6	7	7	8	1	3
0		2	1	7	2	7	1	3	5	3			
8/19	1	4	3	7	4	3	2	3	8	1	8	8	7
0		8	8	7	7	6	1	3	5	6			
8/20	2	6	3	4	4	4	4	5	6	1	2	7	5
8		3	7	5	7	1	6	6	1	1			
8/21	1	1	2	8	4	4	2	6	8	4	4	3	7
0		8	1	8	4	1	1	5	6	4			
8/22	3	6	3	7	7	1	6	7	7	3	7	3	8
8		2	3	3	4	5	2	3	2	3			
8/23	3	3	1	4	3	4	7	3	1	8	5	3	2
8		2	1	3	4	4	5	3	6	3			
8/24	4	8	3	1	3	8	3	5	2	6	7	2	4
0		8	8	5	2	5	3	4	4	3			
8/25	3	2		3	2	4	2	3	4	4	5	4	4
1		5	7	6	6	7	6	3	3	4			
8/26	6	5	4	6	2	2	8	4	8	4	5	5	5
8		7	1	1	1	1	8	8	7	5			
8/27	4	2	3	3	3	4	3	1	2	2	1	1	5
8		8	8	6	5	8	8	8	1	3			

8/28	2	1	1	1	3	5	4	6	1	4	4	4	1
	0	1	6	7	7	7	2	5	3	4			
8/29	3	4	3	4	3	4	5	3	5	7	6	5	8
	0	4	7	6	6	5	4	4	3	1			
8/30	5	5	3	7	3	6	5	2	8	8	6	5	5
	8	1	8	0	4	6	5	3	8	5			
8/31	3	3	6	3	2	3	1	3	3	5	5	2	8
	1	6	7	8	7	3	5	6	3	4			
9/ 1	3	6	1	2	6	1	8	5	6	4	7	7	5
	0	5	6	6	6	7	7	7	0	1			
9/ 2	3	2	3	2	3	4	3	6	5	8	8	6	3
	0	5	3	3	5	7	3	1	6	4			
9/ 3	4	5	6	7	2	5	8	3	3	6	8	8	8
	0	8	8	8	8	5	8	6	8	8			
9/ 4	8	7	7	4	2	3	3	5	4	4	4	5	3
	1	8	8	8	8	8	1	1	6	3			
9/ 5	4	3	2	6	2	6	3	3	5	4	4	8	3
	8	8	7	8	8	8	1	1	8	8			
9/ 6	8	6	7	8	7	7	8	3	4	6	8	1	6
	4	5	2	8	8	8	5	7	1	1			
9/ 7	8	6	4	2	3	7	7	3	6	1	8	6	8
	1	8	7	4	4	5	2	2	4	3			
9/ 8	2	2	1	0	4	5	1	4	6	6	7	7	2
	0	7	7	7	8	8	2	3	3	2			
9/ 9	3	4	3	6	3	2	3	7	3	6	2	7	1
	0	1	2	7	7	8	2	3	5	5			
9/10	3	4	1	4	5	4	7	2	3	7	7	7	8
	0	7	7	7	8	1	2	4	4	4			
9/11	5	6	1	4	6	8	4	4	3	2	2	2	8
	0	7	8	8	8	7	3	3	4	4			
9/12	4	2	2	3	3	3	5	4	3	0	1	6	1
	1	7	7	4	8	7	3	3	5	4			
9/13	3	5	8	3	2	1	4	2	2	7	5	5	1
	7	2	2	3	7	5	5	3	3	7			
9/14	5	3	6	3	5	4	3	5	4	4	5	8	2
	0	7	5	7	8	2	3	5	4	4			
9/15	2	3	4	5	3	2	2	3	3	5	5	8	7
	8	6	7	8	1	1	2	4	3	5			
9/16	2	3	8	4	8	3	4	4	4	1	6	8	1
	8	3	6	7	6	2	8	5	5	2			
9/17	1	1	3	7	6	1	8	8	4	5	4	5	8
	0	2	1	7	8	8	6	6	3	2			
9/18	7	1	7	3	3	3	6	5	3	2	2	4	5
	8	6	7	6	7	7	2	5	1	4			
9/19	4	6	3	6	3	4	4	3	3	4	3	5	4
	1	4	5	5	4	4	4	5	6	4			
9/20	4	5	5	5	5	8	7	6	7	0	2	6	7
	1	4	6	6	6	6	7	5	8	7			
9/21	7	5	3	3	3	5	4	1	6	1	1	7	6
	1	3	2	8	8	7	3	3	1	4			
9/22	4	3	3	5	3	3	2	6	4	2	4	7	6
	2	1	7	8	7	7	7	4	3	2	2		
9/23	3	3	2	4	4	1	5	2	8	8	2	3	5
	0	6	7	8	7	7	3	4	4	3			
9/24	8	2	3	7	5	4	4	4	1	4	1	7	8
	0	8	2	8	1	7	1	7	7	7			
9/25	7	8	1	3	8	8	8		3	4	4	2	7
	0	7	7	2	7	1	3	2	5	2			
9/26	4	5	4	4	1	2	4	5	1	6	2	5	3
	8	8	5	8	3	1	8	8	8	1			
9/27	8	8	8	2	8	3	8	8	8	1	8	8	8
	0	8	8	8	8	1	1	1	1	1			
9/28	8	7	4	4	3	3	5	5	4	3	5	5	6

```
 8            8     6     7     8     7     3     3     8     5
9/29    3     1     4     4     6     4     4     4     4     3     8     8     7
 8            8     2     8     7     2     1     7     7     4
9/30    1     3     4     4     4     6     3     4     6     4     4     4     5
 0            5     8     1     6     1     3     4     6     4
```

3911 weather observations used.
FF+3.0.4 12/03/2003-12:08


242904 - STEVI
1993 - 2003
6/1 - 9/30
Avg Wind Speed
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
22
Hour of Day
3911 Wx Observations
FF+3.0.4 12/03/2003-12:08

FireFamily Plus Diurnal Report
Wind Speed
Station: 242904 - STEVI

Time Frame: 6/1 - 9/30
Data Years: 1993 - 2003

Avg Values by Hour of Day by Date

Date	Hour 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
6/ 1		1	1	3	1	3	3	4	2	2	4	2	3	5		2	2	4	4	1	7	6	8	9
6/ 2	2	3	1	1	4	1	1	2	0	0	2		2	5		3	8	16	3	3	2	3	1	0
6/ 3	2	2	0	2	0	0	0	0	2	1	2	2	4	3		9	5	7	8	8	6	3	1	2
6/ 4	2		1	0	0	1	0	0	1	2	2	2	4	4		3	4	3	3	3	2	0	3	6
6/ 5	0	1	1	2	1	0	1	2	2	1	2	3	4	5		4	3	3	2	5	5	4	2	3
6/ 6	3	3	5	4	5	4	8	7	6	8	2	4	5	4		10	9	11	6	6	5	6	4	3
6/ 7	3	8	2	4	5	4	2	2	3	2	3	3	3	4		10	13	12	10	7	11	9	3	2
6/ 8	14	13	8	13	13	3	3	8	9	5	1	4	6	5		5	7	10	7	9	7	7	7	7
6/ 9	6	2	3	4	3	3	2	8	6	4	4	2	7	4		9	9	7	2	2	1	1	0	1
6/10	2	3	2	2	3	3	2	2	2	1	1	2	3	4		7	2	3	2	1	1	2	2	2
6/11	1	0	0	1	1	1	1	2	3	2	2	2	4	4		4	3	3	3	2	1	0	2	1
6/12	1	2	0	3	2	4	2	3	4	2	2	3	3	4		3	4	3	3	2	7	3	1	2
6/13	2	1	1	2	0	0	1	0	1	2	2	2	2	4		4	3	4	2	2	1	2	2	4
6/14	3	0	2	0	0	0	1	2	1	1	1	1	2	4	4	3	2	3	3		3		1	1
6/15	2	3	0	1	0	2	1	0	1	2	1	2	2	4		3	4	4	5	3	3	1	2	1
6/16	0	1	0	2	0	2	0	0	1	2	2	2	2	5		4	9	5	4	1	2	5	4	12
6/17	5	7	1				1	1	0	2	2	3	3	4		7	5	10	9	7	7	5	6	6
6/18	2	3	4	9	2	2	3	2	3	2	2	2	15	6		8	8	8	3	9	4	3	2	2
6/19	2	3	4	2	2	3	4	6	2	7	4	5	5	6		7	3	3	3	3	2	0	4	0
6/20	1	0	1	2	0	3	0	0	2	2		2	3	3		4	4	4	9	10	7	4	7	4
6/21	4	2	3	3	3	1	0	2	1	1	2	3	3	4		5		11	5	1	5	1	3	2
6/22	2	1	2	2	0	1	1	2	1	1	1	6	4	4		4	2	5	7	6	2	1	2	0
6/23	1	2	2	2	1	2	0	1	0	2	2	2	2	3		17	3	6	5	5	3	3	4	4
6/24	2	3	3	0	1	1	2	1	0	1	3	2	3	4		5	3	4	5		6	1	2	1
6/25	2	3	2	1	0	1	1	0	0	4	2	3	2	3		3	3	3	3	1	0	4	5	1

6/26	2	0	2	0	0	2	1	2	1	1	2	1	2
	4	3	4	6	5	4	5	2	3	2			
6/27	5	4	5	3	2	1	2	2	1	1	2	2	2
	7	2	6	7	3	4	4	6	4	2			
6/28	2	5	2	9	4	3	5	3	5	2	2	5	6
	5	5	3	4	3	2	2	1	2	3			
6/29	1	0	3	0	6	3	2	4	3	6	8	4	3
	4	7	4	5	3	4	4	3	3	2			
6/30	4	1	3	1	2	1	2	1	2	2	1	4	2
	4	9	9	9	8	5	5	1	0	3			
7/ 1	2	4	2	2	1	2	3	0	1	2	1	2	7
	4	6	7	6	8	6	4	4	3	3			
7/ 2	4	2	0	3	1	1	0	0	1	1	3	1	2
	4	2	4	4	5	3	1	1	1	3			
7/ 3	1	1	0	1	0	3	1	2	2	2	1	3	3
	3	3	5	5	5	9		5	4	5	3		
7/ 4	3	2	2	2	0	2	2	2	5	7	5	4	4
	4	6	8	8	3	6	7	9	4	5			
7/ 5	3	2	4	0	1	1	2	1	1	2	6	3	3
	4	3	4	4	4	9	9	4	1	2			
7/ 6	5	2	2	2	0	2	1	0	1	1	2	1	2
	2	4	5	7	5	9	1	5	5	2			
7/ 7	1	1	1	1	4	1	0	1	3	3	1	2	2
	3	2	1	14	3	3		3	0	0			
7/ 8	0	2	2	1	0	0	2	3	2	3	2	3	2
	4	7	5	6	5	3			2	2			
7/ 9	3	2	2	2	1	0	1	2	1	2	2	3	3
	4	3	3	4	3	1	2	0	2	1			
7/10	2	1	1	2	0	1	1	0	1	2	2	2	2
	3	2	1	2	2	2	4	0	0	1			
7/11	1	0	1	0	0	0	1	1	2	2	1	2	2
	3	2	2	2	2	1	3	3	3	2			
7/12	2	0	1	1	1	1	1	1	1	1	2	2	2
	3	2	2	3	4	2	2	3	1	1			
7/13	1	1	0	0	0	3	0	1	2	1	1	2	1
	3	2	2	3	3	3	2	3	6	2			
7/14	3	3	4	3	4	2	1	4	1	3	2	4	3
	3	3	5	8	4	3	6	5	4	1			
7/15	2	4	2	2	0	1	0	2	1	2	1	1	3
	3	3	5	1	2	2	6	4	4	2			
7/16	2	1	3	1	3	2	2	1	3	4	2	1	2
	3	3	2	1	1	7	5	2	1	2			
7/17	0	2	0	1	3	0	3	1	2	1	2	2	2
	4	3	3	1	0	12	3	3	3	1			
7/18	2	1	4	1	0	2	0	0	2	0	1	2	1
	3	2	3	1	8	5	6	5	4	4			
7/19	5	1	2		0	4	2	2	1	0	0	0	0
	3	0	0	1	2	7	8	5	0	3			
7/20	2	0	2	2	0	1	1	0	2	0	0	0	0
	3	3	3	2	2	2	3	1	3	4			
7/21	5	4	1	1	2	0	0	1	1	2	2	2	2
	3	3	3	4	9	4	2	3	5	6			
7/22	4	4	5	4	2	1	2	2	0	3	1	3	3
	4	2	3	2	2	2	0	2	2	2			
7/23	1	4	0	3		3	2	1	2	3	2	3	2
	4	4	3	10	11	3	3	4	5	3			
7/24	4	3	6	1	5	4	1	2	0	2	1	2	1
	3	2	3	2	1	1	4	5	4	2			
7/25	2	1	4	2	1	2	0	2	1	2	3	1	5
	2	4	3	3	0	2	10	7	9	9			
7/26	9	3	3	2	0	1	2	1	1	2	2	2	4
	3	3	3	4	3	4	4	1	3	3			
7/27	6	6	4	3	0	2	1	0	1	1	4	3	9

	4		8	9	9	9	10	8	6	2	3			
7/28	4		4	4	4	4	2	1	4	3	4	5	9	7
	3		6	8	6	7	4	4	2	5	3			
7/29	4		2	1	4	3	6	5	3	5	11	8	5	4
	3		4	4	4	10	6	5	8	2	4			
7/30	2		2	3	3	0	1	0	0	1	1	3	2	2
	3		10	9	8	5	6	7	4	2	0			
7/31	1		4	3	3	4	3	5	2	4	1	3	4	7
	4		7	7	6	5	7	6	4	4	2			
8/ 1	3		1	0	1	1	1	2	0	0	2	2	3	2
	2		2	4	3	1	2	2	1	3	1			
8/ 2	0		1	0	0	0	3	1	2	1	1	1	2	2
	3		2	5	9	8	7	5	5	3	4			
8/ 3	1		0	0	1	2	1	3	0	0	1	3	2	2
	2		3	3	3	2	1	2	5	4	3			
8/ 4	1		1	1	2	2	7	9	2	3	3	3	3	
	4		11	11	4	9	4	3	1	1	3			
8/ 5	0		1	1	2	1	3	6	3	1	5	3	4	3
	3	2	5	9	8	5	4	3	7	6	1			
8/ 6	3		1	1	1	3	2	3	2	1	11		11	5
	2		4	5	4	4	3	0	2	2	4			
8/ 7	0		0	2	2	1	0	1	1	3	3	4	2	4
	4		5	2	3	1	0	3	1	2	1			
8/ 8	2		1	1	0	2	0	1	0	0	0	2	3	3
	4		7	5	9	8	6	3	1	2	1			
8/ 9	4		0	1	1	0	1	2	2	0	1	2	3	3
	3		5	6	5	4	3	0	0	6	2			
8/10	2		0	1	0	0	2	1	0	0	1	3	3	2
	3		6	3	6	6	0	1	1	2	2			
8/11	4		1	1	1	2	2	2	1	1	2	2	2	2
	3		7	7	4	4	6	5	2	2	4			
8/12	2		0	2	1	2	1	2	2	0	2	2	2	2
	3		4	3	4	5	5	5	4	4	4			
8/13	5		3	0	2	0	0	0	0	2	2	2	3	3
	3		6	6	7	4	9	4	3	4	3			
8/14	7		4	2	3	2	4	3	2	4	3	4	4	5
	4		10	4	6	8	7	6	3	2	6			
8/15	3		7	2	3	2	3	3	0	2	1	1	3	2
	4		6	10	6	5	5	2	2	1	3			
8/16	2			2	0	3	2	3	3	5	16	6	10	10
	5		14	12	5	8	7	4	3	3	4			
8/17	0		0	1	1	2	0	0	0	0	1	1	2	1
	3		2	1	1	2	1	4	2	3	3			
8/18	3		1				3	1	5	4	2	2	1	3
	3		3	2	3	2	0	0	3	2	2			
8/19	0		0	1	0	0	0	0	0	0	1	2	2	1
	3		4	3	2	2	2	4	2	2	1			
8/20	2		1	5	2	1	1	1	2	3	3	3	2	2
	3		1	1	5	6	2	2	6	5	5			
8/21	5		3	1	3	1	1	5	2	1	2	3	3	3
	2		3	5	6	12	4	4	0	0	1			
8/22	3		1	3	1	0	2	0	0	0	2	2	2	3
	2		1	1	2	4	3	1	1	5	5			
8/23	2		2	3	1	1	1	0	1	1	0	1	2	1
	3		2	2	0	2	4	8	2	4	3			
8/24	2		2	4	2	5	1	2	2	4	1	1	0	2
	3		3	3	9	8	3	3	7	5	0			
8/25	2		5		0	1	0	1	3	2	2	2	3	2
	3		5	2	10	6	4	0	3	2	1			
8/26	1		3	0	1	1	0	0	1	1	0	1	2	1
	2		6	9	11	14	15	6	6	2	3			
8/27	4		3	0	2	0	1	1	1	0	2	1	5	6
	3		13	14	14	13	9	9	5	4	2			

8/28	3	3	4	1	2	1	1	1	0	1	2	1	2
1		2	2	1	2	3	2	14	6	3			
8/29	2	2	1	0	2	1	0	1	1	1	0	1	2
3		3	2	6	7	8	3	4	3	0			
8/30	1	1	0	1	0	0	1	1	1	1	1	3	2
4		10	5	1	8	5	3	6	0	2			
8/31	2	3	0	1	1	1	2	2	0	0	2	6	3
3		3	2	2	2	0	2	2	4	1			
9/ 1	1	2	0	2	2	1	2	1	2	2	3	1	9
3		6	11	8	6	4	2	5	3	2			
9/ 2	2	3	4	1	4	1	2	2	0	1	2	1	3
3		4	4	3	4	1	2	1	1	3			
9/ 3	1	1	0	0	2	4	0	8	3	2	2	2	3
2		3	3	3	4	5	0	8	14	3			
9/ 4	2	1	1	3	2	2	2	2	0	2	2	3	2
3		5	4	8	10	5	12	8	2	5			
9/ 5	2	4	2	1	2	1	2	2	1	2	2	4	3
4		2	2	8	6	12	12	17	11	9			
9/ 6	7	2	1	5	3	2	2	3	2	2	3	1	2
4		3	2	2	1	0	2	4	4	3			
9/ 7	0	3	0	2	0	1	0	0	2	3	3	3	4
3		3	1	3	5	6	6	0	2	3			
9/ 8	2	1	2	3	0	0	1	0	0	1	0	2	1
4		2	3	2	3	0	1	3	3	2			
9/ 9	1	1	1	1	2	2	2	1	3	2	1	2	2
3		2	2	2	2	0	1	1	0	2			
9/10	0	0	0	0	0	1	0	1	0	0	0	1	1
3		2	3	2	0	0	2	1	3	0			
9/11	1	1	1	1	1	2	2	0	0	0	1	1	4
2		1	2	2	4	0	2	1	2	1			
9/12	1	2	3	1	2	1	0	1	2	0	1	1	1
3		2	2	3	1	0	2	4	2	3			
9/13	1	1	0	1	2	1	2	0	1	1	2	2	2
2		2	1	2	3	4	3	6	3	1			
9/14	3	1	0	0	1	0	2	1	2	1	1	1	2
2		2	1	1	1	2	0	2	3	1			
9/15	1	1	1	1	1	1	0	0	2	1	1	1	1
3		1	1	1	3	4	3	2	3	3			
9/16	3	1	0	2	1	3	3	1	0	1	1	2	2
3		2	8	6	5	4	2	2	2	2			
9/17	5	2	2	2	1	4	5	2	0	1	1	0	1
1		3	1	1	7	2	1	2	4	3			
9/18	8	7	3	3	1	1	2	1	2	0	3	4	7
6		9	6	6	6	5	2	4	4	2			
9/19	1	4	3	2	4	1	3	1	2	2	2	6	8
5		7	8	7	5	7	6	3	2	8			
9/20	7	7	5	5	7	2	9	3	5	3	5	6	10
3		5	7	7	7	9	6	3	2	8			
9/21	4	3	7	1	2	1	1	1	1	1	2	2	2
3		3	1	1	2	0	3	2	2	2			
9/22	1	1	1	0	1	2	2	0	1	1	0	2	2
3	2	2	1	2	2	1	2	1	1	1			
9/23	1	0	1	0	1	2	1	2	0	0	1	1	1
1		2	3	2	2	1	1	3	2	2			
9/24	0	3	1	1	1	2	2	2	1	1	1	2	2
3		3	7	5	7	3	7	2	2	2			
9/25	0	7	5	4	7	5	4		3	2	2	1	2
2		2	2	3	2	1	2	3	2	3			
9/26	2	2	1	1	2	1	1	1	2	2	1	3	3
4		5	6	9	6	4	4	1	2	0			
9/27	2	11	5	8	6	7	8	9	7	8	5	6	6
3		3	4	4	3	5	5	7	6	3			
9/28	2	0	2	0	1	2	2	1	1	2	2	2	1

```
 3            3     3     3     1     0     3     1     0     0
9/29    1     1     1     1     1     1     1     1     1     0     1     2     2
 3            8     8     7     3     6     3    13    10     4
9/30    4     4     4     7     5     7     4     4     1     5     4     6     4
 5            4     6     3     2     1     2     3     1     1
```

3911 weather observations used.
FF+3.0.4 12/03/2003-12:08

FireFamily Plus Wind Speed vs Direction Report

Station:242904 1993 - 2003
June 1 - September 30 by 28 Day Time Periods

28-Day Period Beginning 6/1

			Wind Speed, MPH											
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	AVG PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
	N	PCT	SPEED											
NE	65	7.1	43	4.7	11	1.2	6	0.7						
125	13.6	4.2												
E	33	3.6	17	1.8	1	0.1								
51	5.5	3.1												
SE	55	6.0	15	1.6	1	0.1								
71	7.7	2.7												
S	72	7.8	39	4.2	5	0.5								
116	12.6	3.3												
SW	31	3.4	20	2.2	7	0.8	2	0.2						
60	6.5	4.3												
W	34	3.7	24	2.6	11	1.2	1	0.1						
70	7.6	4.6												
NW	79	8.6	39	4.2	8	0.9	2	0.2						
128	13.9	3.8												
N	105	11.4	76	8.3	28	3.0					1	0.1		
210	22.9	4.2												
CLM	88	9.6												
88	9.6	0.0												
TOT	562	61.2	273	29.7	72	7.8	11	1.2			1	0.1		
919	100.0	3.5												

28-Day Period Beginning 7/1

			Wind Speed, MPH											
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	AVG PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
	N	PCT	SPEED											
NE	74	7.3	30	3.0	5	0.5	1	0.1						
110	10.8	3.2												
E	43	4.2	22	2.2	2	0.2	1	0.1						
68	6.7	3.4												
SE	69	6.8	31	3.1										
100	9.9	2.9												
S	61	6.0	23	2.3	6	0.6	1	0.1						
91	9.0	3.1												
SW	61	6.0	28	2.8	10	1.0								
99	9.8	3.6												
W	42	4.1	49	4.8	13	1.3								
104	10.3	4.4												
NW	101	10.0	39	3.8	8	0.8								
148	14.6	3.2												
N	125	12.3	41	4.0	9	0.9								
175	17.3	3.2												
CLM	119	11.7												
119	11.7	0.0												

TOT	695	68.5	263	25.9	53	5.2	3	0.3				
1014	100.0	3.0										

28-Day Period Beginning 8/1

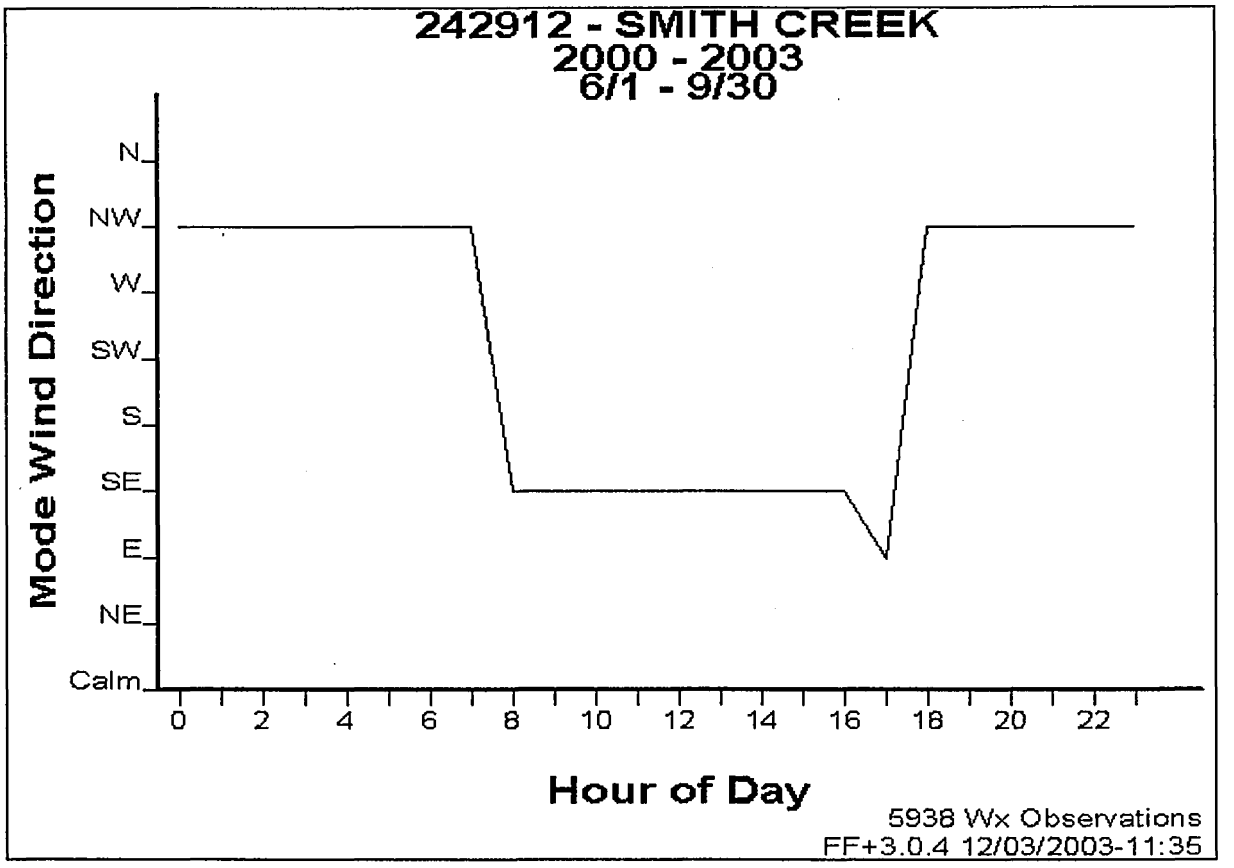
			Wind Speed, MPH									
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	AVG PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
N	PCT	SPEED												
NE	78	7.7	37	3.7	9	0.9	2	0.2						
126	12.5	3.7												
E	44	4.4	12	1.2	6	0.6								
62	6.2	3.0												
SE	108	10.7	26	2.6	2	0.2								
136	13.5	2.8												
S	73	7.2	15	1.5	2	0.2								
90	8.9	2.5												
SW	58	5.8	23	2.3	5	0.5	3	0.3						
89	8.8	3.5												
W	45	4.5	33	3.3	9	0.9	2	0.2						
89	8.8	4.4												
NW	79	7.8	23	2.3	6	0.6								
108	10.7	3.0												
N	95	9.4	45	4.5	12	1.2	3	0.3						
155	15.4	3.8												
CLM	152	15.1												
152	15.1	0.0												
TOT	732	72.7	214	21.3	51	5.1	10	1.0						
1007	100.0	2.9												

28-Day Period Beginning 9/1

			Wind Speed, MPH									
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	AVG PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
N	PCT	SPEED												
NE	63	7.0	27	3.0	5	0.6	1	0.1						
96	10.7	3.4												
E	66	7.3	8	0.9	1	0.1								
75	8.4	2.3												
SE	80	8.9	19	2.1	1	0.1	1	0.1						
101	11.2	2.7												
S	70	7.8	17	1.9	4	0.4								
91	10.1	2.7												
SW	52	5.8	19	2.1	6	0.7								
77	8.6	3.2												
W	50	5.6	14	1.6	6	0.7	1	0.1						
71	7.9	3.3												

NW	84	9.4	19	2.1	8	0.9					1	0.1
112	12.5	3.2										
N	90	10.0	45	5.0	13	1.4	1	0.1				
149	16.6	3.7										
CLM	126	14.0										
126	14.0	0.0										
TOT	681	75.8	168	18.7	44	4.9	4	0.4			1	0.1
898	100.0	2.7										

3903 records used.


242912 - SMITH CREEK
2000 - 2003
6/1 - 9/30
Mode Wind Direction
N
NW
W
SW
S
SE
E
NE
Calm
0
2
4
6
8
10
12
14
16
18
20
22
Hour of Day
5938 Wx Observations
FF+3.0.4 12/03/2003-11:35

FireFamily Plus Wind Speed vs Direction Report

Station:242912 2000 - 2003
June 1 - September 30 by 28 Day Time Periods

28-Day Period Beginning 6/1

			Wind Speed, MPH											
	TOTAL	AVG	0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	PCT	SPEED	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	
NE	32	2.2		32	2.2									
64	4.5	3.4												
E	58	4.0		66	4.6									
124	8.6	3.6												
SE	87	6.1		227	15.8									
314	21.9	4.1												
S	67	4.7		104	7.2	3	0.2							
174	12.1	4.0												
SW	21	1.5		24	1.7									
45	3.1	3.7												
W	58	4.0		44	3.1	7	0.5	1	0.1					
110	7.7	3.8												
NW	231	16.1		185	12.9	19	1.3	6	0.4	1	0.1			
442	30.8	3.9												
N	99	6.9		57	4.0	3	0.2	1	0.1					
160	11.1	3.5												
CLM	4	0.3												
4	0.3	0.0												
TOT	657	45.7		739	51.4	32	2.2	8	0.6	1	0.1			
1437	100.0	3.9												

28-Day Period Beginning 7/1

			Wind Speed, MPH											
	TOTAL	AVG	0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	PCT	SPEED	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	
NE	27	1.8		21	1.4									
48	3.2	3.3												
E	51	3.4		78	5.1									
129	8.5	3.6												
SE	86	5.7		250	16.5									
336	22.1	4.3												
S	42	2.8		116	7.6	2	0.1							
160	10.5	4.4												
SW	21	1.4		34	2.2	1	0.1							
56	3.7	4.1												
W	63	4.2		50	3.3	4	0.3							
117	7.7	3.9												
NW	228	15.0		209	13.8	24	1.6	2	0.1					
463	30.5	3.9												
N	126	8.3		75	4.9	4	0.3	1	0.1					
206	13.6	3.4												
CLM	3	0.2												
3	0.2	0.0												

TOT	647	42.6	833	54.9	35	2.3	3	0.2
1518	100.0	3.9						

28-Day Period Beginning 8/1

			Wind Speed, MPH									
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	PCT	AVG SPEED	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	
NE	28	1.9		14	0.9									
42	2.8	3.1												
E	50	3.3		58	3.8									
108	7.1	3.5												
SE	93	6.2		241	15.9	2	0.1							
336	22.2	4.2												
S	44	2.9		106	7.0	5	0.3							
155	10.3	4.5												
SW	35	2.3		34	2.2	2	0.1							
71	4.7	3.7												
W	96	6.3		42	2.8	1	0.1	1	0.1					
140	9.3	3.1												
NW	296	19.6		155	10.3	27	1.8							
478	31.6	3.7												
N	105	6.9		63	4.2	10	0.7							
178	11.8	3.7												
CLM	4	0.3												
4	0.3	0.0												
TOT	751	49.7		713	47.2	47	3.1	1	0.1					
1512	100.0	3.8												

28-Day Period Beginning 9/1

			Wind Speed, MPH									
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	PCT	AVG SPEED	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	
NE	34	2.5		14	1.0									
48	3.5	2.9												
E	44	3.2		36	2.6									
80	5.9	3.3												
SE	77	5.6		216	15.8									
293	21.5	4.2												
S	44	3.2		114	8.4	4	0.3							
162	11.9	4.4												
SW	34	2.5		29	2.1	3	0.2							
66	4.8	3.7												
W	106	7.8		33	2.4	7	0.5							
146	10.7	3.1												

NW	228	16.7	180	13.2	30	2.2
438	32.1	3.9				
N	84	6.2	39	2.9	2	0.1
125	9.2	3.2				
CLM	6	0.4				
6	0.4	0.0				
TOT	657	48.2	661	48.5	46	3.4
1364	100.0	3.8				

5929 records used.

FireFamily Plus Diurnal Report
Wind Direction
Station: 242912 - SMITH CREEK

Time Frame: 6/1 - 9/30
Data Years: 2000 - 2003

Mode Values by Hour of Day by Date

Date	Hour 0	1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20	21	22	23		
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6/ 2	4	4	4	4	6	6	4	6	6	4	3	8	4
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6/ 3	5	2	7	7	7	7	7	3	3	3	4	3	3
	3	4	4	2	2	3	7	7	7	7	6		
6/ 4	7	7	6	8	8	8	1	3	3	2	2	3	3
	3	2	2	2	1	1	6	7	7	7	7		
6/ 5	7	7	7	6	6	7	1	2	2	2	3	3	3
	4	3	1	3	2	4	5	6	7	7	7		
6/ 6	7	7	7	7	1	7	8	1	2	2	3	1	3
	3	2	2	1	1	1	6	7	8	8	2		
6/ 7	6	7	7	7	7	6	7	3	3	3	2	3	3
	3	2	2	1	3	3	7	7	7	7	6		
6/ 8	8	7	2	7	7	2	1	1	4	3	3	4	1
	3	2	2	5	4	1	5	5	6	2	1		
6/ 9	4	7	3	1	2	1	1	3	3	3	3	3	1
	3	2	2	4	4	1	8	0	8	4			
6/10	6	8	6	8	6	6	7	3	2	2	3	3	2
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	2	3	3	6	2	6	7	7	7	7	7		
6/12	7	7	7	7	7	7	7	2	3	3	3	3	3
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6/13	7	7	7	7	6	8	7	3	3	3	3	3	3
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6/14	7	7	7	7	6	7	7	3	3	3	3	2	2
	3	2	2	1	2	3	7	7	7	7	8		
6/15	6	7	6	6	7	7	4	3	3	3	3	3	3
	3	3	3	2	2	1	7	7	6	2	7		
6/16	7	7	7	7	6	7	8	3	3	3	3	3	2
	3	3	2	2	1	6	7	7	6	7	5		
6/17	8	2	8	8	7	8	6	3	3	3	3	3	3
	3	2	3	3	4	1	1	7	5	7	7		
6/18	7	7	6	4	7	1	6	2	4	3	4	4	3
	1	3	3	3	3	5	1	1	1	4	1		
6/19	5	1	6	7	6	1	7	1	3	3	2	2	3
	8	2	5	4	4	2	5	4	7	7	7		
6/20	7	7	6	6	5	6	3	1	3	1	4	3	3
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6/21	2	7	4	0	4	6	7	1	2	3	3	3	4
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6/22	5	1	7	7	7	5	2	3	7	3	3	1	3
	3	3	3	2	4	5	7	2	7	7	7		
6/23	7	7	7	6	6	6	7	2	3	3	3	3	2
	3	2	2	1	1	1	5	6	1	7	8		
6/24	8	2	7	7	7	8	1	2	3	3	2	3	2
	3	2	2	2	4	3	7	7	7	7	7		
6/25	7	7	7	7	7	7	5	3	3	4	3	3	3
	2	2	2	2	2	3	7	7	7	8	7		

6/26	7	6	6	7	7	7	6	3	3	3	2	2	3
	3	3	3	2	3	6	7	7	7	4			
6/27	4	6	6	7	7	7	7	2	2	3	3	3	3
	3	2	5	4	1	1	7	7	7	4	7		
6/28	6	7	6	5	7	7	7	4	2	3	3	3	2
	3	3	2	2	2	2	2	4	7	7	7		
6/29	7	1	6	7	7	7	7	3	1	7	3	4	3
	4	3	3	3	2	7	1	7	7	7	7		
6/30	7	6	7	7	7	5	7	3	3	4	3	3	3
	3	6	4	6	6	3	7	7	7	7	6		
7/ 1	6	6	7	8	3	2	1	4	3	4	4	3	2
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7/ 2	7	7	6	6	7	5	7	2	4	3	3	3	2
	3	3	3	1	2	6	1	6	4	7	7		
7/ 3	7	7	7	6	7	1	4	7	6	4	3	3	3
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7/ 4	7	7	7	6	1	7	7	1	3	3	2	3	3
	7	4	5	4	6	6	1	7	7	7	7		
7/ 5	0	7	7	7	7	7	8	2	2	2	3	3	4
	6	3	3	2	2	1	7	7	8	7	7		
7/ 6	7	7	7	7	7	7	6	3	3	3	3	3	3
	3	3	2	1	2	4	7	4	7	7	7		
7/ 7	7	7	7	5	6	7	7	4	4	3	3	3	2
	3	3	3	2	1	1	7	7	7	6	7		
7/ 8	7	6	7	5	7	5	4	2	7	3	1	3	2
	6	4	4	3	4	5	5	7	7	6	7		
7/ 9	7	6	6	8		7	7	3	3	3	3	3	2
	2	2	2	2	1	1	4	7	7	7	7		
7/10	7	7	5	6	7	7	8	2	3	3	3	3	3
	3	2	2	2	1	1	7	8	8	8	7		
7/11	7	6	7	4	6	7	8	3	2	3	3	2	2
	3	2	2	2	1	4	7	7	6	7	7		
7/12	6	7	6	7	7	7	5	4	3	3	3	4	2
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7/13	7	7	6	8	6	8	6	1	5	3	3	3	3
	3	3	3	2	4	7	7	4	8	7	7		
7/14	7	3	7	7	3	7	6	3	3	3	3	3	2
	2	2	3	2	1	1	7	7	7	6	7		
7/15	7	7	7	7	7	7	4	4	2	3	3	4	2
	3	2	3	2	2	1	7	8	7	5	7		
7/16	6	7	7	7	5	1	7	4	3	2	3	3	2
	3	2	2	3	7	1	7	7	7	7	7		
7/17	1	7	7	8	7	6	7	2	3	3	3	3	3
	3	2	3	1	6	7	7	2	7	7	6		
7/18	6	7	7	7	6	6	7	2	3	3	3	3	3
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7/19	7	6	7	6	7	6	7	5	1	2	2	3	3
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7/20	7	7	6	7	6	5	7	3	2	2	2	2	2
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	3	3	2	2	1	1	7	7	7	2	7		
7/22	1	6	4	6	2	7	6	3	2	2	3	2	2
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7/23	6	7	6	7	8	6	6	7	3	3	4	3	3
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7/24	5	6	6	7	7	6	1	8	3	3	3	3	2
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7/25	7	4	1	8	1	1	7	7	3	3	3	3	4
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7/26	7	7	7	7	1	2	3	2	2	2	2	3	4
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7/27	7	1	7	6	7	7	7	3	3	3	3	3	4

	3	3	3	3	1	7	7	7	7	7			
7/28	2	7	7	7	7	7	7	4	3	3	3	3	4
	7	4	4	3	6	3	7	7	4	3	7		
7/29	6	7	6	7	5	4	7	3	3	2	3	3	3
	3	3	3	3	3	4	6	7	7	7	7		
7/30	7	7	7	7	7	7	7	1	3	3	3	4	3
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7/31	7	6	5	6	7	5	7	4	3	3	3	3	3
	3	3	3	2	2	2	7	7	7	8	8		
8/ 1	3	5	5	4	7	6	7	3	3	3	3	3	2
	3	3	3	3	3	6	7	7	7	7	7		
8/ 2	7	7	6	7	6	1	7	1	2	2	3	3	3
	3	3	2	1	3	7	7	7	7	7	7		
8/ 3	7	7	7	6	7	7	6	2	3	3	3	2	2
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8/ 4	6	7	7	7	6	7	6	1	3	3	2	3	4
	3	3	2	2	4	4	7	8	7	8	4		
8/ 5	6	8	7	3	5	1	5	3	3	4	3	3	2
	5	2	2	1	4	4	3	6	7	4	7		
8/ 6	1	6	7	5	6	1	2	3	2	3	3	3	3
	3	2	3	2	3	2	7	6	7	7	7		
8/ 7	6	7	7	1	7	7	7	4	2	3	3	1	4
	3	3	2	1	2	3	7	7	7	7	8		
8/ 8	7	7	7	7	2	6	5	7	3	3	3	4	2
	3	3	1	2	1	5	1	6	8	8	1		
8/ 9	6	8	7	2	1	6	7	4	3	3	3	3	3
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8/14	7	5	7	7	7	6	5	2	2	3	2	4	3
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8/15	7	4	7	7	6	6	6	4	2	3	3	3	3
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	3	3	3	3	2	1	6	7	7	7	7		
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8/26	7	7	7	7	7	2	7	7	2	3	3	2	3
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8/27	7	7	6	5	7	7	6	4	3	1	3	2	3
	3	2	2	2	1	5	6	1	7	1	5		

8/28	7	5	6	7	7	0	4	1	3	2	2	2	2
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8/29	7	1	6	7	7	5	7	2	2	2	2	2	2
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8/30	7	6	6	6	6	7	3	3	3	3	3	3	3
	3	3	1	3	2	2	5	7	7	7	7		
8/31	7	7	6	6	7	7	6	2	3	3	3	3	3
	3	3	3	3	2	4	7	7	7	7	7		
9/ 1	7	5	1	7	6	6	6	6	4	3	3	3	3
	3	3	2	3	3	3	7	7	7	7	8		
9/ 2	6	4	7	0	5	7	1	6	3	3	4	3	3
	2	2	1	2	2	6	7	7	7	6	7		
9/ 3		6	6	6	6	7	7	7	3	3	3	3	3
	4	3	3	3	1	7	7	7	4	5	6		
9/ 4	4	7	6	7	6	6	6	6	3	3	3	3	2
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9/ 5	7	6	7	5	5	7	6	3	2	3	3	2	2
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9/ 6		2	7	6	4	3	5	6	5	2	3	3	4
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9/ 7	8	8	5	6	8	7	6	6	2	2	3	3	3
	3	3	3	4	6	1	6	7	7	6	3		
9/ 8	7	7	7	4	7	1	3	4	3	3	4	3	2
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9/ 9	7	7	7	4	6	4	1	1	3	2	3	3	3
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9/10	7	7	6	6	6	6	4	4	1	3	3	3	3
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9/11	4	6	5	6	7	7	3	1	3	3	2	2	4
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9/12	6	5	4	5	6	7	6	6	4	7	3	4	3
	4	3	3	2	1	5	6	7	7	7	7		
9/13	7	6	7	7	7	7	7	5	1	3	3	3	2
	3	3	2	3	2	6	7	7	7	7	7		
9/14	7	7	7	7	7	6	7	7	1	3	3	4	4
	2	3	3	3	4	6	7	7	7	7	6		
9/15	6	6	5	5	7	7	7	7	6	3	4	1	3
	4	0	3	2	4	6	7	7	7	7	8		
9/16	7	7	2	7	7	4	7	5	5	3	3	3	3
	2	4	3	4	2	1	6	7	1	7	7		
9/17		7	6	2	6	7	1	5	3	3	1	2	2
	4	2	2	3	2	1	5	6	6	5	8		
9/18	6	3	6	7	4	6	7	4	3	3	3	2	3
	4	7	5	6	4	6	6	3	1	7	6		
9/19	7	7	7	7	7	5	5	7	3	3	3	3	3
	7	3	3	4	2	4	4	6	4	4	5		
9/20	5	6	5	4	6	7	7	1	7	7	3	3	2
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9/21	7	6	7	7	7	7	7	7	3	2	3	3	3
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9/22	7	6	6	7	7	7	6	7	1	3	2	3	3
	3	3	3	2	4	6	7	6	6	6	6		
9/23	7	7	6	6	7	7	7	1	1	3	3	3	3
	4	3	3	3	2	7	7	4	7	7	7		
9/24	7	7	7	7	7	7	7	6	3	3	3	3	3
	3	3	2	3	2	7	7	7	7	1	1		
9/25	2	3	3	1	1	6	6	7	2	4	3	2	3
	4	3	3	2	2	6	7	7	7	6	7		
9/26	7	7	7	7	7	7	1	6	2	2	3	3	3
	3	3	3	2	2	1	1	7	7	7	7		
9/27	8	7	8	8	6	3	8	6	3	3	3	1	3
	4	2	2	2	2	2	1	5	7	1	8		
9/28	8	5	7	6	6	6	6	6	3	3	3	3	3

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 3     3     3     1     3     8     7     6     7     6     2
9/29   7     5     1     6     6     7     7     6     2     2     2     2     2
 4     2     2     1     4     1     7     6     7     1     6
9/30   7     5     6     5     6     6     5     6     3     3     2     3     2
 3     3     3     2     2     6     7     5     7     5     7
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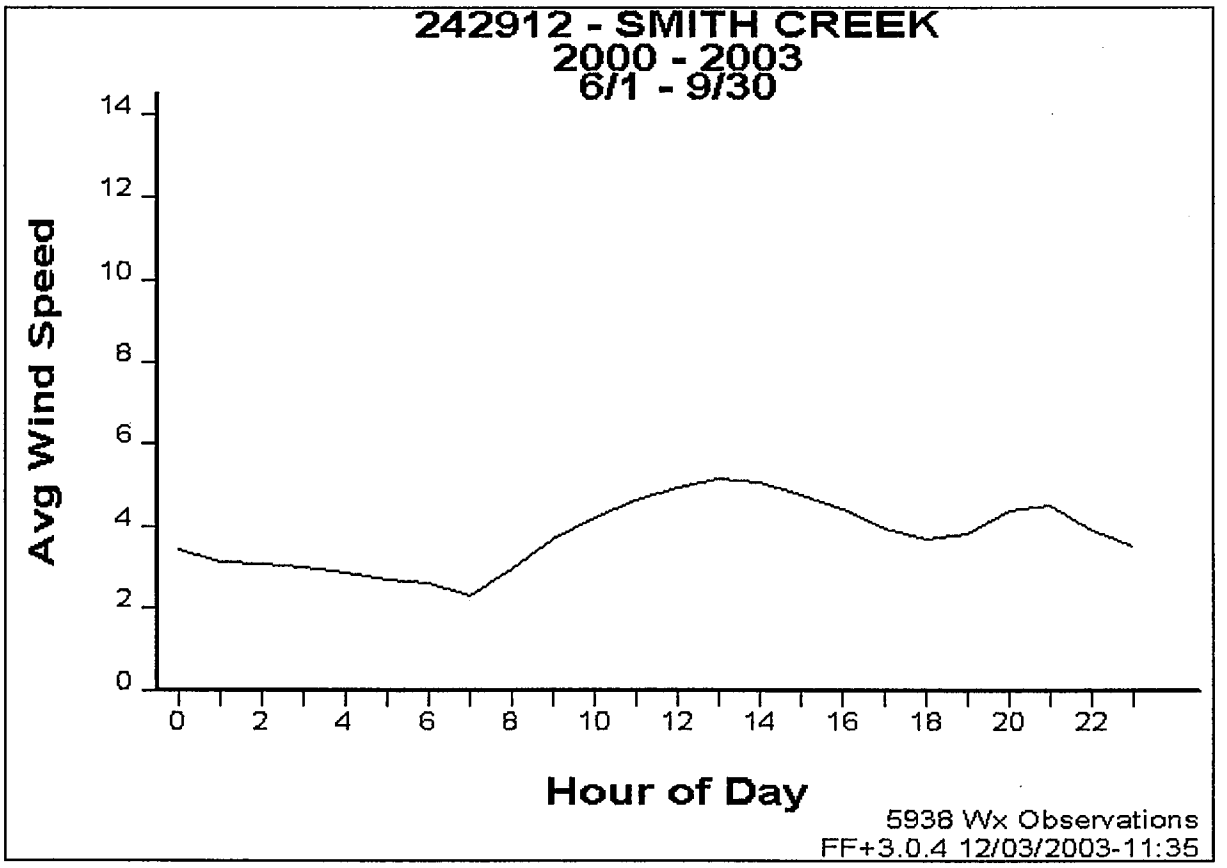
5938 weather observations used.
FF+3.0.4 12/03/2003-11:35


242912 - SMITH CREEK
2000 - 2003
6/1 - 9/30
Avg Wind Speed
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
22
Hour of Day
5938 Wx Observations
FF+3.0.4 12/03/2003-11:35

FireFamily Plus Diurnal Report
Wind Speed
Station: 242912 - SMITH CREEK

Time Frame: 6/1 - 9/30
Data Years: 2000 - 2003

Avg Values by Hour of Day by Date

Date	Hour 0	1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20	21	22	23		
6/ 1	7	4	4	5	3	3	2	3	4	4	5	5	4
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6/ 2	2	2	3	3	4	3	2	4	5	3	5	5	5
	5	5	5	5	4	4	2	3	3	3	3		
6/ 3	5	5	3	2	2	2	2	4	3	4	5	5	6
	3	5	6	5	4	3	3	5	4	4	4		
6/ 4	3	4	6	5	6	3	2	2	4	4	4	6	6
	5	5	5	4	4	5	2	4	4	6	3		
6/ 5	4	3	3	3	3	2	2	3	4	4	5	5	5
	3	4	5	5	3	7	5	4	5	4	5		
6/ 6	8	9	8	8	10	9	7	4	5	5	6	5	5
	6	7	7	6	6	6	4	5	5	4	4		
6/ 7	4	3	4	3	5	3	3	3	4	5	5	6	5
	5	6	4	5	5	4	4	6	6	5	4		
6/ 8	3	3	3	6	4	1	1	2	3	3	4	5	4
	4	3	2	4	5	3	2	2	3	3	4		
6/ 9	3	3	3	4	1	2	1	2	2	3	4	3	4
	4	3	3	3	3	5	5	6	6	8			
6/10	2	3	3	3	2	3	2	1	3	2	4	4	5
	5	4	4	5	3	4	4	3	3	3	3		
6/11	5	3	3	3	2	3	3	2	4	3	3	4	6
	5	6	5	6	4	4	4	5	5	4	4		
6/12	4	3	3	4	2	2	2	3	4	4	5	6	6
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6/13	3	3	3	3	2	2	2	3	3	4	4	5	4
	6	5	5	5	3	4	4	3	5	6	4		
6/14	2	3	3	2	2	2	2	2	2	3	4	5	4	6
	6	6	6	5	3	2	3	4	5	4	2		
6/15	2	3	2	3	4	2	2	2	4	4	4	5	5
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8/26	3	3	3	3	3	2	2	2	2	3	4	4	5	
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8/27	5	5	5	2	5	2	2	2	2	2	4	4	7	
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9/10	2	3	3	2	1	2	1	2	2	3	4	4	5
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9/15	3	3	4	3	3	3	3	4	2	3	6	4	6
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9/16	3	3	2	3	3	2	3	2	3	3	5	4	6
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9/17		3	2	3	2	2	2	2	2	2	3	3	3
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9/19	3	6	7	6	5	2	2	3	3	3	4	4	5
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9/20	6	8	8	5	7	5	6	4	6	5	5	5	5
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9/28	3	3	2	2	2	2	2	2	2	4	4	5	5

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 5     4     5     3     3     2     3     3     4     4     4
9/29   3     5     5     5     3     4     3     4     4     4     4     5     5
 5     4     6     6     4     5     7    11     8     5     4
9/30   5     3     3     4     3     4     3     4     4     4     4     5     3
 5     5     4     4     3     3     3     2     3     1     3
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5938 weather observations used.
FF+3.0.4 12/03/2003-11:35

FireFamily Plus Diurnal Report
Wind Direction
Station: 242902 - DEER MT

Time Frame: 6/1 - 9/30
Data Years: 2002 - 2003

Mode Values by Hour of Day by Date

Date	Hour 0	1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20	21	22	23		
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	7	7	6	3	6	3	5	3	7	7	7		
6/ 2	6	7	7	7	7	6	6	6	7	7	6	7	7
	7	7	7	7	7	7	7	7	1	7			
6/ 3	7	6		7	7	6	6	5	5	6	7	7	7
	7	7	7	7	7	7	3	1	1	1	1		
6/ 4	3	4	4	5	5	5	6	6	7	7	7	6	6
	7	3	7	1	1	7	1	7	1	1	1		
6/ 5	1	2	2	4	4	6	6	6	6	6	6	7	4
	7	7	1	7	1	7	1	1	1	2	4		
6/ 6	4	5	6	6	7	1	2	2	2	2	2	1	6
	7	1	1	1	1	1	1	1	1	2	2		
6/ 7	2	2	3	3	4	4	5	3	4	5	6	6	6
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6/ 8	6	6	1	1	1	6	1	5	7	6	6	6	6
	7	7	7	5	6	5	5	5	6	5	5		
6/ 9	1	7	7	8	1	4	1	1	1	1	1	2	1
	1	7	3	1	8	8	1	1	1	8			
6/10	1	6	5	7	1	3	4	4	6	5	6	6	6
	7	7	7	7	6	7	7	6	2	1	1		
6/11	1	1	8	7	7	6	5	5	5	5	5	5	7
	7	6	6	7	7	7	7	2	8	7	7		
6/12	7	7	7	7	7	6	6	5	3	4	5	7	1
	7	3	7	8	1	1	1	1	1	1	1		
6/13	1	1	1	1	2	4	4	4	3	4	3	4	3
	4	4	1	1	3	5	1	1	1	2	3		
6/14	3	4	5	4	4	4	4	4	4	4	6	6	6
	6	8	7	7	8	7	7	7	1	7	1		
6/15	1	1	1	1	4	4	1	1	8	7	7	6	6
	7	7	7	4	4	1	4	7	1	1	1		
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6/17	1	1	1	1	1	2	3	3	3	4	6	4	4
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6/18	4	6	3	3	4	4	4	4	4	4	4	3	5
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6/19	5	6	6	7	6	5	6	4	4	4	4	5	6
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6/20	7	1	1	1	1	2	3	7	4	4	4	4	5
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6/21	1	1	1	3	4	4	4	4	4	4	4	4	6
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6/22	4	5	4	4	3	1	4	4	5	2	4	4	6
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7/ 6	1	1	8	3	1	1	1	4	4	4	4	5	8
	8	8	7	7	4	4	4	1	1	4	1		
7/ 7	1	3	3	3	4	2	5	1	2	3	4	5	5
	7	7	6	6	3	1	1	1	1	1	2		
7/ 8	2	4	3	4	1	3	5	5	1	7	5	6	6
	6	6	6	7	7	7	7	7	7	7	7		
7/ 9	6	6	6	6	5	5	4	4	4	4	3	6	6
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7/10	4	1	4	4	2	4	3	4	3	4	4	4	5
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7/11	2	1	1	1	1	1	4	1	1	5	6	5	5
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7/12	1	1	1	1	2	3	3	2	3	4	4	1	5
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7/13	1	3	7	1	1	1	2	2	3	3	4	4	4
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7/14	6	3	7	5	7	6	5	4	4	4	5	6	6
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7/15	1	1	1	1	1	1	2	2	1	1	4	4	7
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7/16	2	3	4	4	4	1	1	4	2	3	4	4	4
	4	5	6	6	4	3	3	3	2	4	4		
7/17	1	1	2	4	4	4	3	4	3	4	4	4	5
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7/18	1	1	1	1	1	1	4	2	4	4	4	4	6
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7/19	1	4	5	5	5	5	1	7	1	2	4	1	5
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7/20	5	5	6	8	7	7	7	2	3	6	6	4	5
	6	6	7	7	7	7	7	7	7	7	7		
7/21	7	1	7	1	1	1	3	1	1	4	4	6	5
	7	7	7	1	1	1	1	1	1	2	2		
7/22	2	2	2	2	3	4	2	3	3	3	3	4	4
	5	3	2	7	7	7	7	6	7	5	4		
7/23	4	5	5	5	5	3	4	4	4	4	5	4	4
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7/24	7	7	6	5	4	4	5	6	5	4	4	6	3
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7/26	3	4	3	4	4	4	4	4	4	4	5	6	6
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7/27	5	5	4	5	5	4	4	4	5	6	7	7	7

	7	6	6	7	7	7	7	7	7	7				
7/28	7	7	4	4	4	4	5	5	5	6	6	6	6	
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7/29	6	7	6	6	6	6	5	5	6	6	6	7	6	
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7/30	6	6	5	5	5	5	6	5	4	4	4	6	6	
	7	6	6	7	7	7	7	7	6	5	6			
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8/ 1	1	1	7	4	4	2	4	4	4	4	4	5	6	
	6	6	6	7	7	1	1	1	1	1	3			
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	7	7	7	7	7	7	7	1	1	7	1			
8/ 3	1	1	1	1	3	2	4	4	4	4	4	4	4	
	6	7	7	3	7	7	2	4	3	3	4			
8/ 4	4	4	4	4	3	6	6	2	6	3	4	3	5	6
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8/11	7	7	7	5	3	4	4	4	4	5	3	5	5	
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	7	7	7	7	6	1	1	1	1	1	1			
8/15	1	1	1	3	4	4	4	4	4	4	4	4	4	
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8/16	4	4	4	4	4	4	4	4	4	5	6	7	7	
	7	7	7	7	7	7	7	7	7	7	7			
8/17	7	7	7	7	5	5	4	5	5	6	7	6	7	
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8/18	2	3	3	3	3	4	4	4	4	4	4	4	5	
	5	6	7	7	7	7	1	1	1	1	1			
8/19	1	5	4	4	5	4	4	4	4	4	5	6	6	
	6	6	7	1	7	1	1	1	1	1	1			
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8/21	1	0	1	1	1	1	1	4	4	3	4	4	6	
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8/26	1	4	4	3	4	4	4	4	4	4	3	3	3	
	5	5	5	6	5	5	3	4	4	5	7			
8/27	5	1	1	1	1	1	1	1	2	1	4	5	1	
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8/28	2	2	2	2	2	2	2	7	4	4	4	4	4
	3	3	1	2	1	2	1	1	1	2			
8/29	2	2	2	2	2	2	2	2	3	2	3	5	4
	5	6	5	1	1	1	1	6	2	2	2		
8/30	5	5	5	4	5	4	5	4	4	4	4	5	6
	5	1	3	3	5	4	4	6	6	7	1		
8/31	1	1	1	4	5	4	5	6	4	4	4	5	6
	7	6	7	7	7	7	7	7	7	7	6		
9/ 1	7	5	5	4	5	5	5	6	6	6	6	6	6
	6	6	7	7	7	7	7	7	7	7	7		
9/ 2	7	7	5	5	1	6	1	1	1	2	2	5	6
	6	6	6	1	7	7	7	1	2	1	1		
9/ 3	1	1	1	4	4	4	4	4	4	4	4	5	5
	6	6	6	6	6	6	7	6	1	1	2		
9/ 4	1	1	1	1	4	5	1	4	4	4	4	4	3
	5	5	5	5	6	7	7	1	1	3	7		
9/ 5	4	4	4	4	3	4	4	5	5	4	5	4	5
	5	4	4	5	5	6	1	1	1	1	4		
9/ 6	1	1	1	1	1	3	5	5	1	3	4	2	3
	3	3	4	2	3	4	4	1	4	4	4		
9/ 7	4	4	4	4	4	4	4	4	4	4	4	4	4
	4	4	4	4	4	3	5	4	1	4	5		
9/ 8	5	5	4	4	5	5	5	5	5	4	5	6	6
	6	6	6	6	5	6	5	5	6	5	5		
9/ 9	5	5	5	5	5	5	5	4	5	4	5	4	6
	6	6	7	7	7	7	7	1	3	1	2		
9/10	8	1	1	4	3	4	4	4	4	4	4	4	5
	4	4	3	2	2	7	3	7	1	1	1		
9/11	5	6	1	1	1	1	5	1	1	1	1	6	6
	6	6	6	6	5	1	1	1	1	1	1		
9/12	1	1	6	1	1	1	3	4	4	4	4	5	5
	7	7	7	2	7	7	6	6	7	7	7		
9/13	7	7	7	7	6	7	6	7	7	6	6	6	7
	7	7	7	7	7	7	7	7	7	7	6		
9/14	5	4	4	4	5	5	4	4	4	4	4	4	5
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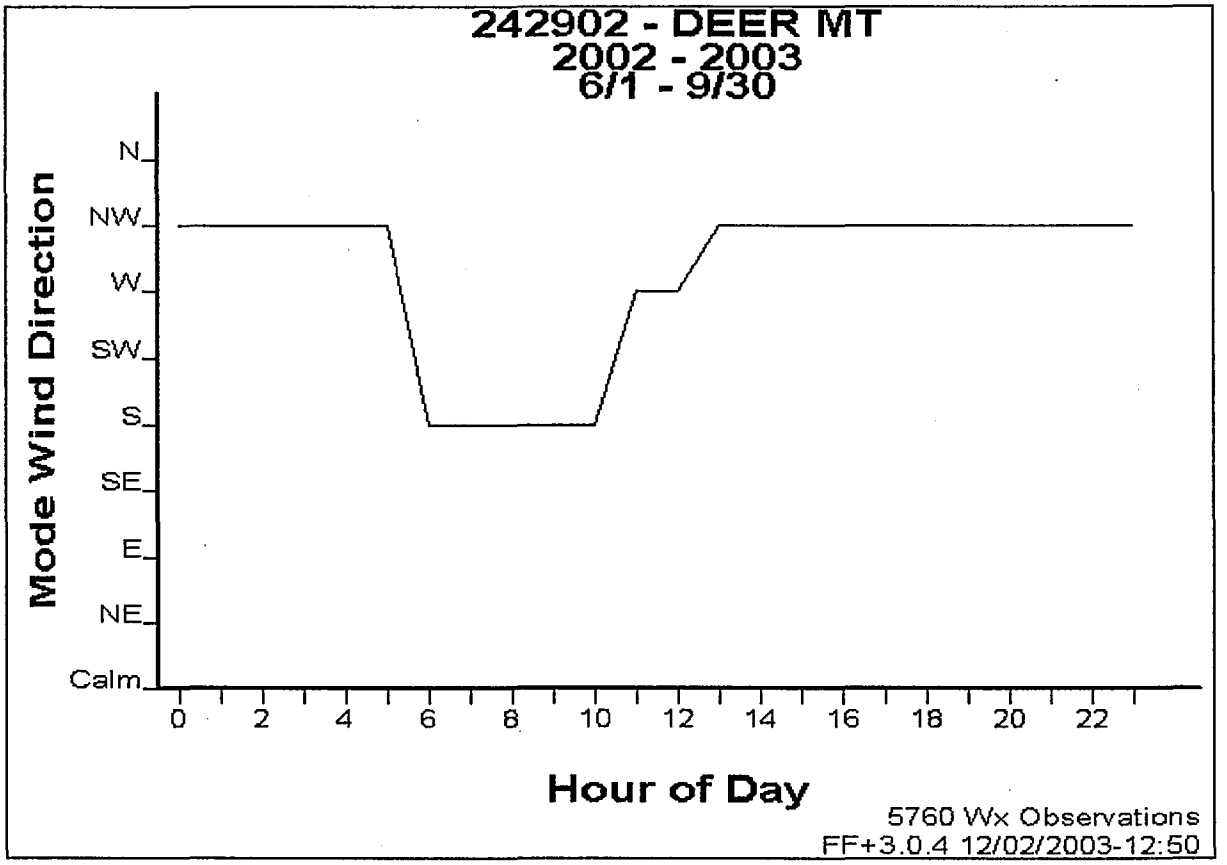
9/15	4	4	4	4	4	4	4	4	4	4	4	3	4
	3	4	3	4	5	5	5	5	4	5	4		
9/16	4	1	1	4	3	3	4	7	7	7	7	7	7
	7	7	7	7	7	7	7	7	7	6	6		
9/17	6	7	7	7	7	7	7	7	7	6	6	7	7	6
	7	7	7	7	7	7	7	7	7	7	5		
9/18	5	5	4	4	4	4	4	4	4	4	4	5	6	6
	6	6	6	6	6	6	6	6	4	5	4		
9/19	5	5	5	4	4	4	4	4	4	4	4	4	5	6
	6	6	6	6	6	7	6	6	6	6	7		
9/20	6	6	7	7	6	7	7	7	7	7	6	7	6
	6	7	6	7	7	6	7	7	7	6	7		
9/21	7	6	7	7	7	6	6	6	6	6	6	7	7
	7	1	7	7	7	7	7	7	7	7	6		
9/22	6	6	5	5	5	5	5	5	5	5	5	6	6
	6	7	7	7	7	7	7	7	7	6	6		
9/23	6	6	6	6	4	6	6	6	6	6	6	6	6
	6	6	7	7	7	7	7	7	7	7	7		
9/24	6	7	7	7	7	7	6	6	4	5	6	5	6
	6	7	7	7	7	7	7	1	1	1	1		
9/25	2	2	1	1	1	1	1	4	4	6	6	5	6
	7	7	7	7	7	7	7	7	7	7	7		
9/26	6	6	6	4	5	5	6	5	4	6	5	6	6
	6	7	7	7	7	1	7	1	6	5	2		
9/27	7	7	1	1	1	1	1	2	5	2	1	6	1
	1	1	1	1	1	1	1	1	1	1	2		
9/28	3	3	4	4	4	4	3	4	4	4	4	4	4

```
 5     6     6     6     7     4     1     1     1     1
9/29   2     2     2     2     2     2     2     3     3     3     4     6
 1     1     1     1     1     1     2     2     4     2
9/30   3     3     3     4     4     4     4     4     4     4     4     4
 5     6     6     5     8     7     1     2     4     4     1

5760 weather observations used.
FF+3.0.4 12/02/2003-12:50
```


242902 - DEER MT
2002 - 2003
6/1 - 9/30
Mode Wind Direction
N
NW
W
SW
S
SE
E
NE
Calm
0
2
4
6
8
10
12
14
16
18
20
22
Hour of Day
5760 Wx Observations
FF+3.0.4 12/02/2003-12:50

FireFamily Plus Diurnal Report
Wind Speed
Station: 242902 - DEER MT

Time Frame: 6/1 - 9/30
Data Years: 2002 - 2003

Avg Values by Hour of Day by Date

Date	Hour 0	1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23			
6/ 1	8	9	7	5	8	11	9	7	5	8	6	8	8
10	13	7	6	7	7	8	9	10	11	9			
6/ 2	12	9	13	14	16	13	10	12	12	10	12	18	13
13	13	12	15	13	10	8	10	12	9	10			
6/ 3	7	9		8	7	7	5	5	4	5	6	7	10
12	9	13	10	10	12	11	13	13	9	11			
6/ 4	9	9	8	8	8	8	7	3	4	5	6	7	7
6	8	9	11	9	10	10	10	11	9	8			
6/ 5	7	3	5	8	7	7	7	6	7	6	6	6	9
8	9	9	11	9	14	9	10	9	9	8			
6/ 6	11	10	10	11	9	9	11	10	9	6	6	7	7
9	11	11	14	15	12	14	13	14	9	10			
6/ 7	10	11	10	9	10	8	5	4	4	5	5	6	7
7	11	11	11	9	12	9	8	10	12	12			
6/ 8	10	8	9	7	8	8	7	9	9	9	11	10	10
14	11	14	12	13	19	12	10	13	9	10			
6/ 9	7	5	8	3	5	5	5	5	4	5	4	4	5
5	5	7	7	7	8	8	9	9	10				
6/10	6	9	7	17	8	9	10	9	6	5	7	7	10
11	11	18	14	14	19	14	11	10	8	8			
6/11	10	9	7	8	7	8	6	6	9	8	5	8	9
8	8	11	10	10	10	11	8	10	11	11			
6/12	9	8	8	8	6	5	4	3	4	5	5	5	6
5	7	10	10	8	7	5	5	5	7	6			
6/13	6	5	5	5	4	4	3	5	5	5	9	8	11
10	4	5	6	6	11	9	9	8	5	5			
6/14	8	8	8	10	12	12	13	11	7	5	6	7	8
8	9	10	9	9	11	9	8	8	9	6			
6/15	6	6	8	7	7	7	8	7	3	4	5	6	7
10	11	9	9	8	8	8	9	9	7	9			
6/16	8	8	6	7	7	7	5	3	5	5	5	6	7
10	8	9	9	8	7	13	11	12	12	11			
6/17	13	10	9	6	5	6	6	6	7	7	8	7	10
8	9	8	10	9	6	9	7	10	7	10			
6/18	11	5	8	14	17	10	10	11	11	11	11	14	19
17	9	9	10	8	14	10	13	9	10	8			
6/19	8	7	11	9	11	8	7	7	7	7	7	8	7
16	7	5	9	11	9	5	7	8	5	3			
6/20	3	4	7	9	6	4	8	12	10	8	6	5	6
15	9	11	12	13	14	12	15	12	13	11			
6/21	12	11	8	6	5	7	9	10	11	7	9	8	11
11	15	16	11	8	13	4	12	11	9	12			
6/22	9	11	7	6	5	6	6	5	5	6	6	7	10
14	11	12	10	11	9	9	8	9	7	5			
6/23	5	4	7	6	5	5	6	5	5	5	5	6	7
9	12	11	12	8	6	6	8	11	8	8			
6/24	9	7	9	11	5	5	7	5	5	6	4	5	6
6	9	10	10	10	8	8	9	10	7	7			
6/25	4	3	3	5	6	7	6	4	4	6	6	9	6
7	11	12	9	9	12	13	10	11	11	10			

6/26	8	7	6	6	7	6	5	5	5	5	5	7	7
5	10	10	11	7	9	8	16	13	17	15			
6/27	11	13	10	11	11	10	11	9	10	10	10	8	10
10	10	8	14	12	12	10	12	9	10	11			
6/28	11	13	12	8	8	12	9	12	9	5	6	9	9
9	8	7	8	7	8	11	10	8	7	8			
6/29	16	10	11	11	14	11	9	14	17	15	9	11	12
10	10	8	11	11	10	9	12	10	10	11			
6/30	7	8	7	5	6	7	12	8	7	7	8	7	8
11	13	13	15	16	16	13	13	12	12	11			
7/ 1	8	6	5	4	5	6	4	4	5	7	5	8	10
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7/ 2	11	10	8	9	8	8	7	6	6	6	8	8	10
9	12	12	12	13	12	12	11	9	8	9			
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12	17	15	15	17	14	11	16	14	15	10			
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7/ 6	7	6	7	8	7	5	3	3	4	4	6	6	5
6	6	7	9	13	9	14	10	8	9	9			
7/ 7	10	9	9	11	10	6	6	8	9	5	5	5	5
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7/ 8	11	14	11	21	17	14	12	18	8	13	7	7	11
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7/15	7	5	4	3	5	5	4	3	4	4	4	5	4
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7/18	9	8	6	5	5	6	4	4	3	4	5	5	5
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7/19	4	5	7	7	5	5	5	4	5	4	4	4	5
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7/20	9	9	9	6	8	8	5	3	2	4	4	6	6
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7/21	12	6	8	9	6	5	4	4	3	4	4	4	5
5	9	8	6	8	9	9	7	10	9	10			
7/22	7	5	5	4	5	4	4	5	5	5	6	7	6
6	7	9	9	9	11	7	8	6	4	6			
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5	11	11	11	8	14	8	5	8	5	9			
7/25	9	10	9	8	9	4	5	6	4	8	7	7	8
9	8	6	5	5	11	9	8	20	9	9			
7/26	13	11	11	11	11	10	8	9	6	7	5	6	8
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7/27	10	6	7	8	8	8	8	7	6	8	7	8	13

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7/28	9	9	7	8	7	8	9	8	6	7	9	13	13
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7/29	9	8	9	11	9	8	6	5	10	11	8	11	10
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7/30	7	8	9	8	8	7	9	7	7	7	7	10	10
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8/ 1	6	5	4	5	6	4	8	9	9	6	5	6	8
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6	9	12	13	10	10	10	10	12	10	9			
8/13	8	6	7	7	6	6	7	7	5	5	5	6	8
8	12	11	11	11	15	16	14	14	14	11			
8/14	10	10	11	10	8	7	9	7	5	7	8	10	12
11	12	13	15	14	13	11	13	13	13	10			
8/15	9	10	8	7	8	8	9	9	9	10	10	9	10
9	10	8	7	7	9	9	12	15	10	12			
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8/28	8	8	5	6	8	6	6	6	3	3	4	5	5
5	7	6	6	9	6	15	11	8	11	11			
8/29	12	11	11	10	9	10	11	11	8	9	8	8	7
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8/30	4	7	6	7	6	6	6	5	5	5	5	6	5
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8/31	6	6	5	6	6	6	11	5	4	7	6	7	7
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12	12	10	10	8	6	10	11	11	8	7			
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9	11	12	14	13	13	13	12	11	9	11			
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8	11	11	12	13	12	12	10	8	9	10			
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11	11	10	13	13	15	15	15	18	16	12			
9/26	14	10	11	7	6	10	10	6	10	7	7	9	5
10	11	10	8	7	11	14	13	13	10	10			
9/27	8	7	7	5	6	8	7	5	6	6	6	5	7
8	8	11	10	8	6	7	5	8	7	5			
9/28	5	4	3	6	5	7	9	7	8	7	8	7	8

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9/29	7	8	8	8	8	10	11	8	9	9	9	8	7	6
	8	8	8	13	9	9	11	18	13	8	6			
9/30	8	8	10	11	11	11	11	8	9	10	10	9	10	
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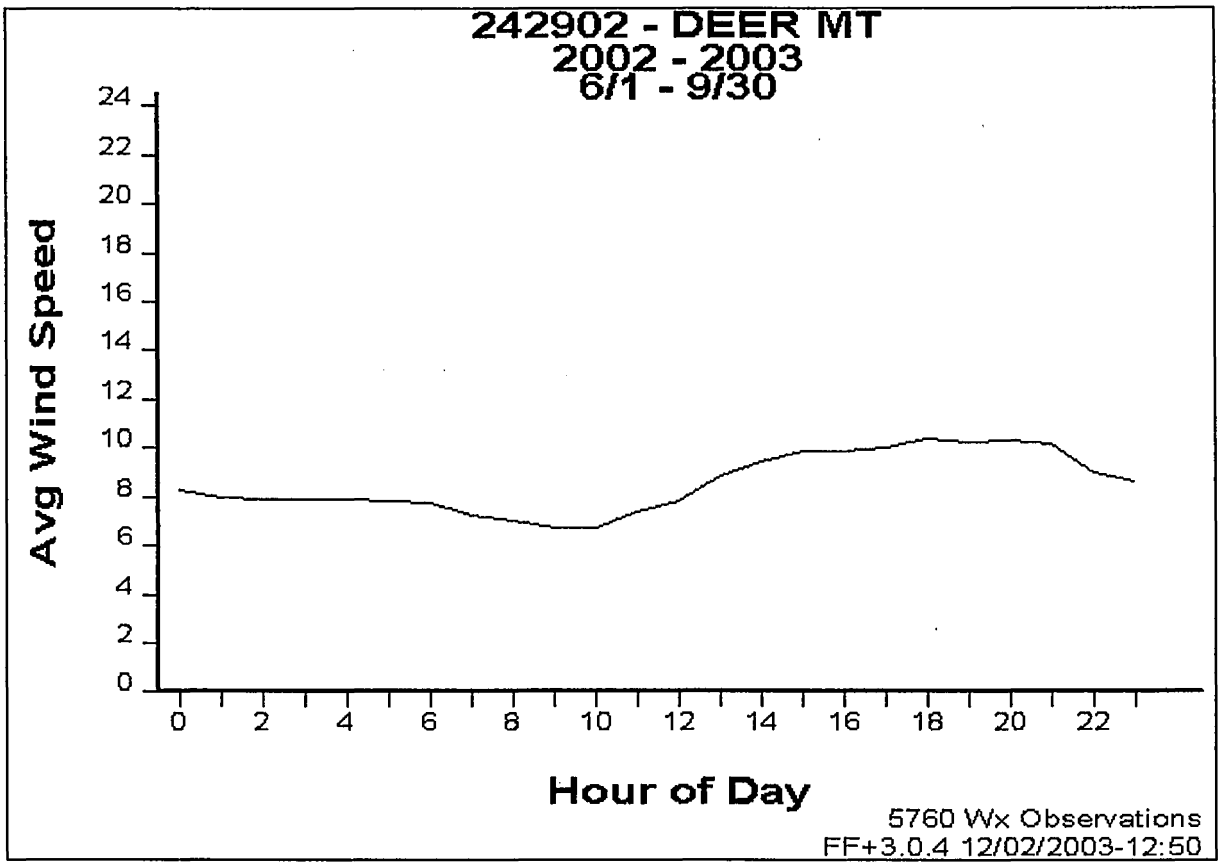
5760 weather observations used.
FF+3.0.4 12/02/2003-12:50


242902 - DEER MT
2002 - 2003
6/1 - 9/30
Avg Wind Speed
24
22
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
22
Hour of Day
5760 Wx Observations
FF+3.0.4 12/02/2003-12:50

FireFamily Plus Wind Speed vs Direction Report

Station:242902 1969 - 2003
June 1 - September 30 by 28 Day Time Periods

28-Day Period Beginning 6/1

			Wind Speed, MPH											
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	AVG PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
N	PCT	SPEED												
NE					3	1.8								
3	1.8	5.7												
E					1	0.6								
1	0.6	7.0												
SE					4	2.3	2	1.2						
6	3.5	6.8												
S	1	0.6			3	1.8	4	2.3						
8	4.7	6.9												
SW	1	0.6			7	4.1	2	1.2						
10	5.8	6.0												
W	4	2.3			16	9.4	13	7.6	5	2.9	1	0.6	1	0.6
40	23.4	8.9												
NW	7	4.1			26	15.2	30	17.5	7	4.1	3	1.8	1	0.6
74	43.3	8.8												
N	3	1.8			14	8.2	9	5.3	3	1.8				
29	17.0	7.4												
CLM														
TOT	16	9.4			74	43.3	60	35.1	15	8.8	4	2.3	2	1.2
171	100.0	8.2												

28-Day Period Beginning 7/1

			Wind Speed, MPH											
	TOTAL		0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	N	AVG PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
N	PCT	SPEED												
NE	3	0.3	4	0.4	1	0.1	2	0.2						
10	1.0	7.3												
E	2	0.2	7	0.7	2	0.2	2	0.2						
13	1.4	7.1												
SE	5	0.5	22	2.3	6	0.6			1	0.1	2	0.2		
36	3.8	7.6												
S	7	0.7	7	0.7	8	0.8	1	0.1						
23	2.4	6.3												
SW	10	1.0	28	2.9	13	1.4	6	0.6			1	0.1		
58	6.1	7.4												
W	28	2.9	110	11.5	88	9.2	21	2.2	11	1.2	2	0.2		
260	27.3	8.2												
NW	26	2.7	130	13.6	111	11.6	29	3.0	4	0.4	4	0.4		
304	31.9	8.2												
N	39	4.1	110	11.5	70	7.3	18	1.9	1	0.1	5	0.5		
243	25.5	7.4												
CLM	6	0.6												

6	0.6	0.0												
TOT	126	13.2	418	43.9	299	31.4	79	8.3	17	1.8	14	1.5		
953	100.0	7.8												

28-Day Period Beginning 8/1

			Wind Speed, MPH											
			0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	TOTAL N	AVG PCT SPEED	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
NE	4	0.4	3	0.3					1	0.1				
8	0.8	4.6												
E	5	0.5	2	0.2	1	0.1			2	0.2				
10	1.0	6.2												
SE	6	0.6	29	2.9	18	1.8			2	0.2	1	0.1		
56	5.5	7.2												
S	3	0.3	15	1.5	15	1.5			3	0.3	1	0.1		
37	3.7	8.5												
SW	9	0.9	50	4.9	30	3.0			8	0.8	1	0.1	2	0.2
100	9.9	7.7												
W	23	2.3	108	10.7	92	9.1			25	2.5	4	0.4	4	0.4
256	25.3	8.3												
NW	24	2.4	129	12.7	116	11.5			31	3.1	6	0.6	3	0.3
309	30.5	8.2												
N	47	4.6	112	11.1	54	5.3			15	1.5	1	0.1		
229	22.6	6.4												
CLM	7	0.7												
7	0.7	0.0												
TOT	128	12.6	448	44.3	326	32.2			87	8.6	14	1.4	9	0.9
1012	100.0	7.6												

28-Day Period Beginning 9/1

			Wind Speed, MPH											
			0 - 3		4 - 7		8 - 12		13 - 18		19 - 24		>24	
Dir	TOTAL N	AVG PCT SPEED	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT	N	PCT
NE	3	0.4	1	0.1	2	0.3								
6	0.9	4.8												
E	1	0.1	2	0.3					1	0.1				
4	0.6	7.3												
SE	3	0.4	21	3.1	14	2.1			3	0.4	1	0.1		
42	6.3	7.7												
S	2	0.3	7	1.0	12	1.8			1	0.1	2	0.3		
24	3.6	8.9												
SW	4	0.6	19	2.8	18	2.7			13	1.9	3	0.4		
57	8.5	9.5												

W	10	1.5	62	9.3	50	7.5	17	2.5	7	1.0		
146	21.9	8.5										
NW	26	3.9	78	11.7	60	9.0	21	3.1	5	0.7	3	0.4
193	28.9	8.2										
N	44	6.6	87	13.0	42	6.3	13	1.9	3	0.4	2	0.3
191	28.6	6.7										
CLM	5	0.7										
5	0.7	0.0										
TOT	98	14.7	277	41.5	198	29.6	69	10.3	21	3.1	5	0.7
668	100.0	7.8										

2830 records used.

TASKS

1. Attend BEMRP meetings with Forest Service and University of Montana personnel.

2. Develop historical weather data necessary for the modeling environment (Fire Family Plus).

3. **Compile, develop, and/or become familiar with the data layers required for use in FARSITE, FlamMap, and the Minimum Travel Time.**

4. Use the above models to map fire hazard and identify optimal fuel treatment patterns to mitigate fire spread into wildland-urban interface areas.

5. Research reporting and presentation of model(s) methodology, output, and results.

Fires 2003

Mapping fuel characteristics and condition in support of the Northern Rockies Multiple Agency Coordination Group

Donald Long
Matthew Rollins
Tracey Frescino

Introduction

On August 12th, 2003 scientists at the Missoula Fire Sciences Laboratory were asked to support the Northern Rockies Multiple Agency Coordination Group (MAC) in efforts to evaluate potential fire activity for 33 large fires, managed by 4 Area Command Teams, in Western Montana (Figure 1). Ongoing research projects into fire behavior modeling, wind modeling, smoke production, and fuels mapping were applied directly in managing these rapidly spreading, severe fires. This report describes application of LANDFIRE protocols for development of the geospatial inputs for the FARSITE fire area simulator, widely used by federal and state agencies to simulate the spread of wildland fire across landscapes (Finney 1998).

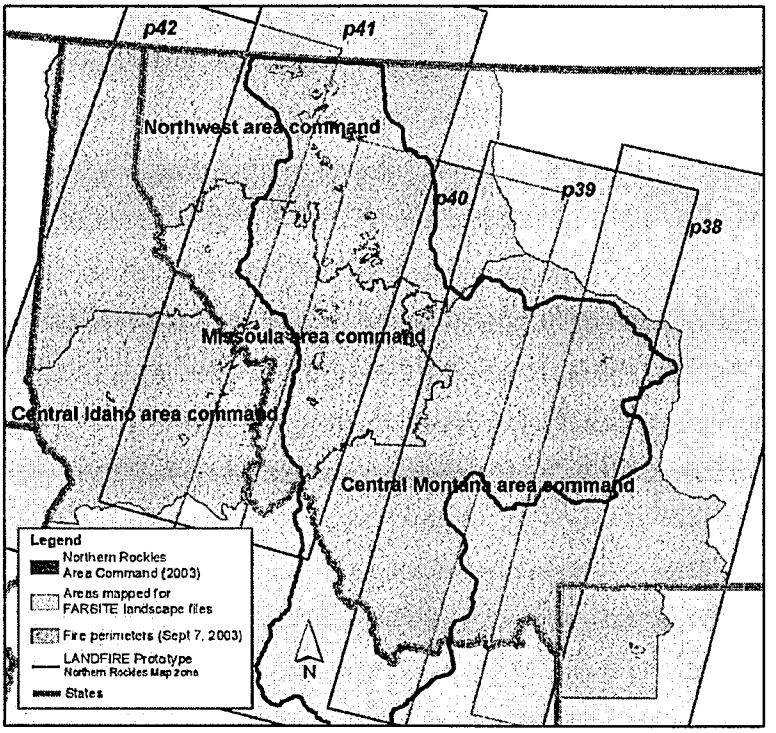


Figure 1.

The LANDFIRE fuels mapping protocols integrate extensive field reference data, information from remote sensing, ecosystem simulation, and biophysical gradient

modeling to create maps of vegetation and fuel characteristics. The MAC group required a rapid response effort for creating the fuels and vegetation data layers needed to implement FARSITE for predicting the spread and behavior of fires as a planning tool within the MAC group's area of operations. Overlap between the Northern Rockies LANDFIRE prototype area and MAC area of operations (Figure 1) created a unique opportunity to use the LANDFIRE reference database and biophysical modeling approaches for providing an immediate deliverable for fire management and planning.

In addition to the LANDFIRE spatial database we acquired existing fuels data for the area of operations from the USDA Forest Service Northern Region Headquarters in Missoula, Montana and elevation and recent satellite imagery from the USGS EROS Data Center (EDC) in Sioux Falls, South Dakota. Without the quick response from Region 1 and the EDC to our data needs we would have been unable to provide fuels maps over such a large area in such a short time.

Creation of 30 m resolution FARSITE fuel maps for the 2003 firefighting efforts incorporated three data sources, including:

- **Biophysical settings** created form a regional scale terrain and climate model
- **Potential Vegetation Types** (PVT's) created by merging the biophysical settings map with a national landuse/land cover map (NLCD) and mapped riparian areas from the Region 1 database
- **Vegetation classes** created by classifying LANDSAT 5 and LANDSAT 7 satellite imagery from the summer of 2002 and 2003

These data were analyzed and combined according to the flowchart illustrated below.

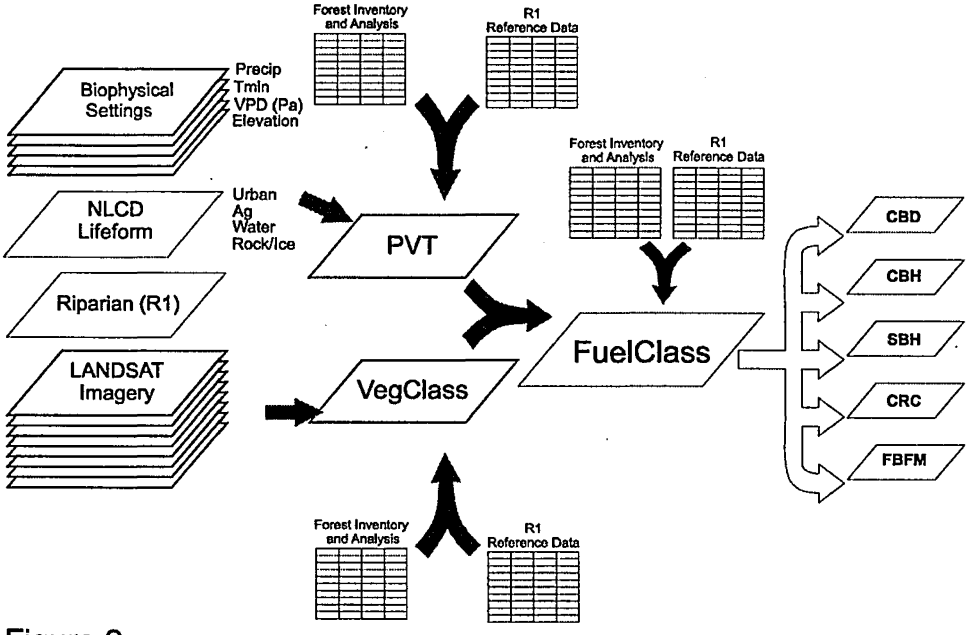


Figure 2.

Biophysical Settings

We used classification and regression tree analysis to spatially model the distribution of seven biophysical settings within the area boundary (Table 1). We used field collected plot data from the Landfire Reference Database including 6156 plots from the Forest Inventory and Analysis (FIA) program, 4332 plots from the BLM, 8078 plots from USFS, and 230 plots from USGS, totaling 18796 plots as training data for building classification tree models.

Table 1.

PVT	PVT Description
1	Upper Subalpine Zone dominated by either subalpine fir, engelmann spruce, lodgepole pine, whitebark pine, and alpine larch
2	Lower Subalpine Zone dominated by subalpine fir, engelmann spruce, lodgepole pine, Douglas-fir, and western larch
3	Mesic Montane Zone dominated by western redcedar, grand fir, western hemlock, Douglas-fir, western larch, and ponderosa pine
4	Xeric Montane Zone dominated by Douglas-fir and ponderosa pine
5	Juniper
6	Sagebrush
7	Herbaceous

We used four climate variables and three topographic variables as predictor variables in the model (Table 2). The climate variables were extracted from a 1KM resolution DAYMET dataset and resampled to 90 meters using a 25 by 25 focalmean window in ArcInfo. The topographic elevation variable was extracted from the 30 meter resolution National Elevation Dataset and resampled to 90 meters using a Nearest Neighbor routine in ArcInfo. Percent slope and aspect degrees were derived from the elevation variable using Erdas Imagine algorithms. Aspect was transformed to a radiation index which assigns a zero to ne direction (cool, wet) and 1 to sw (drier, hotter).

Table 2.

Predictor variable	Units	Description
Precipitation (PPT)	Cm	Average total precipitation.
Temperature (TVN)	Degrees C	Average day-to-day minimum temperature.
Radiation (RT)	W/m2	Average shortwave radiation.
Humidity (HV)	%	Average water vapor pressure.
Elevation (ELEV)	Meters	Elevation from mean sea level.
Aspect (TRASP)	0 to 1	Transformed index for radiation and wetness.
Slope (SLP)	%	The rate of change from one cell to the next

We implemented the classification tree using See5 software (RuleQuest Research Pty Ltd, Australia). Predictions of PVTs were generated within the area boundary using a customized tool in Imagine developed by the Remote Sensing Application Center.

Potential vegetation Types

Potential vegetation types were modeled for the entire area by combining the biophysical settings data, slope and aspect classes from the DEM data, selected landuse/landcover categories from the National Landcover Database (NLCD), and a riparian vegetation layer from a Region 1 vegetation mapping effort. Combinations of these databases were then assigned a potential vegetaton type (Table 3).

Table 3

Biophysical Setting	Slope-Aspect Class	NLCD Class	Riparian Class	Potential Vegetation Type
Upper Subalpine	All	Forest	None	Upper Subalpine Forest
Lower Subalpine	Northerly	Forest	None	Lower Subalpine – Mesic
Lower Subalpine	Flat and southerly	Forest	None	Lower Subalpine – Xeric
Mesic Montane	Northerly	Forest	None	Mesic Montane – Mesic
Mesic Montane	Flat and southerly	Forest	None	Mesic Montane – Xeric
Xeric Montane	Northerly	Forest	None	Xeric Montane – Mesic
Xeric Montane	Flat and southerly	Forest	None	Xeric Montane – Xeric
Upper Sulpalpine	All	Shrub-Herb	None	Upper Sulpalpine Shrub-Herb
Lower Subalpine	All	Shrub-Herb	None	Lower Subalpine Shrub-Herb
Mesic Montane	All	Shrub-Herb	None	Mesic Montane Shrub-Herb
Xeric Montane	All	Shrub-Herb	None	Xeric Montane Shrub-Herb
Juniper/Sage/Herb	All	Forest	None	Juniper/Sage/Herb Forest
Juniper/Sage/Herb	All	Shrub-Herb	None	Juniper/Sage/Herb Shrub-Herb
All	All	Wetlands	Riparian	Riparian
All	All	Agricultural	All	Agricultural
All	All	Urban/Barren	All	Urban/Barren
All	All	Water	All	Water

Vegetation Classes

Plot data from the LANDFIRE reference database were grouped into 25 vegetation class categories (Table 4). These categories functioned as proxies for the different fuel conditions that could potentially exist in the area and enabled us to group plots with similar fuel model conditions as well as canopy characteristics for FARSITE input data. These 25 categories were assigned to each plot in the database, provided it had enough information to do so. We extracted coordinates for each plot and created a training site data layer in the GIS. This layer was used to run a supervised image classification in ERDAS for each of the five LANDSAT scenes for the area (Figure 1) that produced a map representing the 25 vegetation classes described in Table 4.

Table 4.

Vegetation Class	Seral Class	Canopy Cover Class	Height Class
1	Barren	0-10%	0-20 FT TALL
2	Herbaceous	0-10%	0-20 FT TALL
3	Xeric Shrubs	0-10%	0-20 FT TALL
4	Mesic Shrubs	0-10%	0-20 FT TALL
5	Hardwood Trees	11-30%	21-60 FT TALL

6	Hardwood Trees	31-60%	21-60 FT TALL
7	Hardwood Trees	61-100%	21-60 FT TALL
8	Early Seral Trees	11-30%	0-20 FT TALL
9	Early Seral Trees	11-30%	21-60 FT TALL
10	Early Seral Trees	11-30%	61+ FT TALL
11	Early Seral Trees	31-60%	0-20 FT TALL
12	Early Seral Trees	31-60%	21-60 FT TALL
13	Early Seral Trees	31-60%	61+ FT TALL
14	Early Seral Trees	61-100%	0-20 FT TALL
15	Early Seral Trees	61-100%	21-60 FT TALL
16	Early Seral Trees	61-100%	61+ FT TALL
17	Late Seral Trees	11-30%	0-20 FT TALL
18	Late Seral Trees	11-30%	21-60 FT TALL
19	Late Seral Trees	11-30%	61+ FT TALL
20	Late Seral Trees	31-60%	0-20 FT TALL
21	Late Seral Trees	31-60%	21-60 FT TALL
22	Late Seral Trees	31-60%	61+ FT TALL
23	Late Seral Trees	61-100%	0-20 FT TALL
24	Late Seral Trees	61-100%	21-60 FT TALL
25	Late Seral Trees	61-100%	61+ FT TALL

FARSITE Data Layers

The final step in the process was to combine the Potential Vegetation Layer and the Vegetation Class layer and extract the associated database and assign fuel models and other tree and shrub characteristics required by FARSITE. Each combination in the database was assigned a "custom" fuel model number for FARSITE with following descriptions:

- FARSITE Fuel Model 15 : Upper subalpine shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 18 : Upper subalpine moderately dense to dense timber types
- FARSITE Fuel Model 21 : Lower subalpine grass and herbaceous vegetation types
- FARSITE Fuel Model 25 : Lower subalpine shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 28 : Lower subalpine moderately dense to dense timber types on southerly aspects
- FARSITE Fuel Model 30 : Lower subalpine moderately dense to dense timber types on northerly aspects
- FARSITE Fuel Model 31 : Mesic montane grass and herbaceous vegetation types
- FARSITE Fuel Model 35 : Mesic montane shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 38 : Mesic montane moderately dense to dense timber types on southerly aspects

- FARSITE Fuel Model 39 : Mesic montane moderately dense and dense ponderosa pine types
- FARSITE Fuel Model 40 : Mesic montane moderately dense to dense timber types on northerly aspects
- FARSITE Fuel Model 41 : Xeric montane and riparian grass and herbaceous vegetation types
- FARSITE Fuel Model 42 : Xeric montane shrub and herbaceous vegetation types
- FARSITE Fuel Model 45 : Xeric montane and riparian shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 48 : Xeric montane and riparian moderately dense to dense timber types on southerly aspects
- FARSITE Fuel Model 49 : Xeric montane moderately dense and dense ponderosa pine types
- FARSITE Fuel Model 50 : Xeric montane and riparian moderately dense to dense timber types on northerly aspects

Canopy characteristics were assigned to each combination as well and were designed to represent the array of canopy conditions most useful for driving crown fire behavior in FARSITE as well as reduction of wind for modeling surface fire behavior.

References

Finney, M.A. 1998. FARSITE: fire area simulator – model development and evaluation. Research Paper RMRS-RP-4. US Department of Agriculture, Forest Service, 47 pp.

R1/MAGSIM MTT Modeling – Fuels Crosswalk

The crosswalk of fuel assignments used for FARSITE modeling in the summer of 20003 to fuel assignments used for MTT modeling in the BERMP project was based primarily on four attributes in the BERMP stand database: habitat type group (HT_GRP), size class (SIZE CLASS), density (DENSITY), and species (SPECIES). The following four tables show how each of these attributes were crosswalked to the categories used for the fuel assignments, which included PVT Group, Height Class, Density Class, and Species Group. The stand attributes appear on the right hand side of the tables and the fuel assignment categories appear on the left hand side of the tables.

Table 1.

PVT GROUP#	PVT GROUP NAME	HT_GRP
1	Upper Subalpine Forest	G1, G2
2	Lower Subalpine Forest - Mesic	D3, E2
3	Lower Subalpine Forest - Xeric	F1, F2
4	Upper Montane Forest - Mesic	C2, D2
5	Upper Montane Forest - Xeric	C1
6	Lower Montane Forest - Mesic	B2, B3
7	Lower Montane Forest - Xeric	A2, B1
8	Upper Subalpine Shrub - Herbaceous	NF5
11	Lower Montane Shrub - Herbaceous	NF1, NF2A
13	Agricultural	XX1
14	Urban/Barren	XX4
15	Water	XX5

Table 2.

HEIGHT CLASS	SIZE_CLASS
0-20 FT TALL	AGR, CLOSED-HERB, CLOSED-LOW-SHRUB, NF, NS, OPEN-HERB, OPEN-LOW-SHRUB, OPEN-MID-SHRUB, OPEN-TALL-SHRUB, SS
21-60 FT TALL	PMU, POLE
61+ FT TALL	LARGE, LMU, MEDIUM, MMU, VERY-LARGE, VLMU, VLTS

Table 3.

DENSITY CLASS	DENSITY
0% Canopy Cover	0
1-10% Canopy Cover	1
11-30% Canopy Cover	2
31-60% Canopy Cover	3
61-100% Canopy Cover	4

Table 4.

PVT GROUP NAME	SPECIES GROUP	SPECIES
Upper Subalpine Forest	Early Seral Trees	AL,WB
	Late Seral Trees	AF,ES_AF
	Mesic Shrubs	MESIC-SHRUBS,NS
Lower Subalpine Forest - Mesic	Early Seral Trees	DF,DF-LP,L-DF-AF,L-DF-LP,LP
	Hardwood Trees	QA,QA-MC
	Late Seral Trees	AF,C,DF-AF,DF-LP-AF
	Mesic Shrubs	MESIC-SHRUBS,NS
Lower Subalpine Forest - Xeric	Early Seral Trees	L-DF,L-DF-LP,LP
	Hardwood Trees	QA-MC
	Late Seral Trees	AF,AL-WB-AF,L-DF-AF,WB-ES-AF
	Mesic Shrubs	MESIC-SHRUBS,NS
Upper Montane Forest - Mesic	Early Seral Trees	L,L-DF-LP,L-LP
	Late Seral Trees	ES,DF-GF,L-DF-GF
	Mesic Shrubs	MESIC-SHRUBS
Upper Montane Forest - Xeric	Early Seral Trees	L-DF, L-DF-PP, L-PP, L-PP-LP
	Hardwood Trees	QA-MC
	Herbaceous	UPLAND-GRASSES
	Late Seral Trees	DF, GF
	Mesic Shrubs	NS
Lower Montane Forest - Mesic	Early Seral Trees	L-PP, PP
	Hardwood Trees	CW, CW-MC, QA, QA-MC
	Herbaceous	UPLAND-GRASSES
	Late Seral Trees	DF, L-DF, L-DF-PP, PP-DF
	Mesic Shrubs	NS
Lower Montane Forest - Xeric	Early Seral Trees	PP
	Herbaceous	NATIVE-FORBS
	Late Seral Trees	DF, PP-DF
	Mesic Shrubs	NS
	Xeric Shrubs	XERIC-SHRUBS
Upper Subalpine Shrub/Herbaceous	Herbaceous	ALPINE-GRASSES
Lower Montane Shrub/Herbaceous	Herbaceous	ALTERED-GRASSES, UPLAND-GRASSES
	Mesic Shrubs	MESIC-SHRUBS
Agricultural	Agricultural	AGR
Urban/Barren	Barren	NF
Water	Water	WATER

Once these attributes were crosswalked, the stand database was reduced and fuel assignments made to all unique occurrences of the fuel assignment categories as shown below in Table 5. Explanations of the fuel attributes are included following this table.

Table 5.

PVT GROUP	SPECIES GROUP	DENSITY CLASS	HEIGHT CLASS	FBFM	CNCV	STHT	CNBH	CNBD
Upper Subalpine Forest	Mesic Shrubs	1-10%	0-20 FT TALL	15	0	0	0	0
	Early Seral Trees	11-30%	0-20 FT TALL	15	20	15	2	3
			21-60 FT TALL	15	15	20	3	3
			61+ FT TALL	15	20	30	3	5
	Late Seral Trees	11-30%	0-20 FT TALL	15	15	10	2	5
			21-60 FT TALL	15	15	35	5	7
			61+ FT TALL	15	25	50	8	9
		31-60%	0-20 FT TALL	15	20	10	1	3
			21-60 FT TALL	18	20	35	3	5
			61+ FT TALL	18	30	45	8	10
		61-100%	0-20 FT TALL	15	35	45	4	12
			21-60 FT TALL	18	25	35	5	15
			61+ FT TALL	18	40	65	5	20
Lower Subalpine Forest - Mesic	Mesic Shrubs	1-10%	0-20 FT TALL	25	0	0	0	0
	Hardwood Trees	11-30%	0-20 FT TALL	25	5	15	1	1
			21-60 FT TALL	25	5	15	1	1
			61+ FT TALL	25	30	30	3	2
		61-100%	0-20 FT TALL	25	30	30	3	2
	Early Seral Trees	11-30%	0-20 FT TALL	25	20	15	2	3
			21-60 FT TALL	25	15	20	3	3
			61+ FT TALL	25	20	30	3	5
		31-60%	0-20 FT TALL	25	40	10	2	4
			21-60 FT TALL	30	40	45	15	10
			61+ FT TALL	30	35	55	15	12
		61-100%	0-20 FT TALL	25	50	15	3	10
			21-60 FT TALL	30	50	40	5	15
			61+ FT TALL	30	50	70	6	20
	Late Seral Trees	11-30%	0-20 FT TALL	25	15	10	2	5
			21-60 FT TALL	25	15	35	5	7
			61+ FT TALL	25	25	50	8	9
		31-60%	0-20 FT TALL	25	20	10	1	3
			21-60 FT TALL	30	20	35	3	5
			61+ FT TALL	30	30	45	8	10
		61-100%	0-20 FT TALL	25	35	45	4	12
			21-60 FT TALL	30	25	35	5	15
			61+ FT TALL	30	40	65	5	25
Lower Subalpine Forest - Xeric	Mesic Shrubs	1-10%	0-20 FT TALL	25	0	0	0	0
	Hardwood Trees	11-30%	0-20 FT TALL	25	5	15	1	1
	Early Seral	11-30%	0-20 FT TALL	25	20	15	2	3

	Trees		21-60 FT TALL	25	15	20	3	3
			61+ FT TALL	25	20	30	3	5
		31-60%	0-20 FT TALL	25	40	10	2	4
			21-60 FT TALL	28	40	45	15	10
			61+ FT TALL	28	35	55	15	12
		61-100%	0-20 FT TALL	25	50	15	3	10
			21-60 FT TALL	28	50	40	5	15
			61+ FT TALL	28	50	70	6	20
	Late Seral Trees	11-30%	0-20 FT TALL	25	15	10	2	5
			21-60 FT TALL	25	15	35	5	7
			61+ FT TALL	25	25	50	8	9
		31-60%	0-20 FT TALL	25	20	10	1	3
			21-60 FT TALL	28	20	35	3	5
			61+ FT TALL	28	30	45	8	10
		61-100%	0-20 FT TALL	25	35	45	4	12
			21-60 FT TALL	28	25	35	5	15
			61+ FT TALL	28	40	65	5	20
Upper Montane Forest - Mesic	Mesic Shrubs	1-10%	0-20 FT TALL	35	0	0	0	0
	Early Seral Trees	11-30%	0-20 FT TALL	35	20	15	2	3
			21-60 FT TALL	35	15	20	3	3
		31-60%	61+ FT TALL	40	35	55	15	12
		61-100%	21-60 FT TALL	40	55	50	10	15
			61+ FT TALL	40	55	60	8	18
	Late Seral Trees	31-60%	0-20 FT TALL	35	20	10	1	3
			61+ FT TALL	40	30	45	8	10
		61-100%	21-60 FT TALL	40	60	50	3	20
			61+ FT TALL	40	70	65	5	25
Upper Montane Forest - Xeric	Herbaceous	1-10%	0-20 FT TALL	31	0	0	0	0
	Mesic Shrubs	1-10%	0-20 FT TALL	35	0	0	0	0
	Hardwood Trees	11-30%	0-20 FT TALL	35	10	15	2	1
	Early Seral Trees	11-30%	0-20 FT TALL	35	20	15	2	3
			21-60 FT TALL	35	15	20	3	3
			61+ FT TALL	35	25	40	8	8
		31-60%	0-20 FT TALL	35	35	15	2	5
			21-60 FT TALL	38	45	35	10	9
			61+ FT TALL	38	45	55	15	12
	Late Seral Trees	11-30%	0-20 FT TALL	35	15	15	2	3
			21-60 FT TALL	35	20	40	3	5
			61+ FT TALL	35	25	60	5	8
		31-60%	0-20 FT TALL	35	30	10	1	3
			21-60 FT TALL	38	35	30	3	8
			61+ FT TALL	38	40	45	8	10
		61-100%	61+ FT TALL	38	60	65	5	25
Lower Montane Forest - Mesic	Herbaceous	1-10%	0-20 FT TALL	41	0	0	0	0
	Mesic Shrubs	1-10%	0-20 FT TALL	45	0	0	0	0
	Hardwood Trees	11-30%	0-20 FT TALL	45	5	15	1	1
			21-60 FT TALL	45	5	15	1	1
		31-60%	0-20 FT TALL	45	10	10	1	2
			21-60 FT TALL	45	10	10	1	2
			61+ FT TALL	45	10	10	1	2

		11-30%	61+ FT TALL	45	30	30	3	2
	Early Seral Trees	11-30%	0-20 FT TALL	45	20	15	2	3
			21-60 FT TALL	45	15	20	3	3
			61+ FT TALL	45	20	30	3	5
		31-60%	0-20 FT TALL	49	40	20	2	8
			21-60 FT TALL	49	40	45	15	10
			61+ FT TALL	49	35	55	15	12
	Late Seral Trees	11-30%	0-20 FT TALL	45	15	10	2	5
			21-60 FT TALL	45	15	35	5	7
			61+ FT TALL	45	25	50	8	9
		31-60%	0-20 FT TALL	45	20	10	1	3
			21-60 FT TALL	50	20	35	3	5
			61+ FT TALL	50	30	45	8	10
Lower Montane Forest - Xeric	Herbaceous	1-10%	0-20 FT TALL	41	0	0	0	0
	Xeric Shrubs	1-10%	0-20 FT TALL	42	0	0	0	0
	Mesic Shrubs	1-10%	0-20 FT TALL	45	0	0	0	0
	Early Seral Trees	11-30%	0-20 FT TALL	45	20	15	2	3
			21-60 FT TALL	45	15	20	3	3
			61+ FT TALL	45	20	30	3	5
		31-60%	0-20 FT TALL	49	30	15	2	6
			61+ FT TALL	49	35	55	15	12
	Late Seral Trees	11-30%	0-20 FT TALL	45	15	10	2	5
			21-60 FT TALL	45	15	35	5	7
			61+ FT TALL	45	25	50	8	9
		31-60%	0-20 FT TALL	45	20	10	1	3
			21-60 FT TALL	48	20	35	3	5
			61+ FT TALL	48	30	45	4	10
		61-100%	21-60 FT TALL	48	25	35	5	18
Upper Subalpine Shrub/ Herbaceous	Herbaceous	1-10%	0-20 FT TALL	15	0	0	0	0
Lower Montane Shrub/ Herbaceous	Herbaceous	1-10%	0-20 FT TALL	41	0	0	0	0
Lower Montane Shrub/ Herbaceous	Mesic Shrubs	1-10%	0-20 FT TALL	45	0	0	0	0
Agricultural	Agricultural	1-10%	0-20 FT TALL	14	0	0	0	0
Urban/Barren	Barren	1-10%	0-20 FT TALL	99	0	0	0	0
Water	Water	1-10%	0-20 FT TALL	98	0	0	0	0

The first fuel attribute is "FBFM" or Fire Behavior Fuel Model, which is basically a a "custom" fuel model number used in FARSITE with following descriptions:

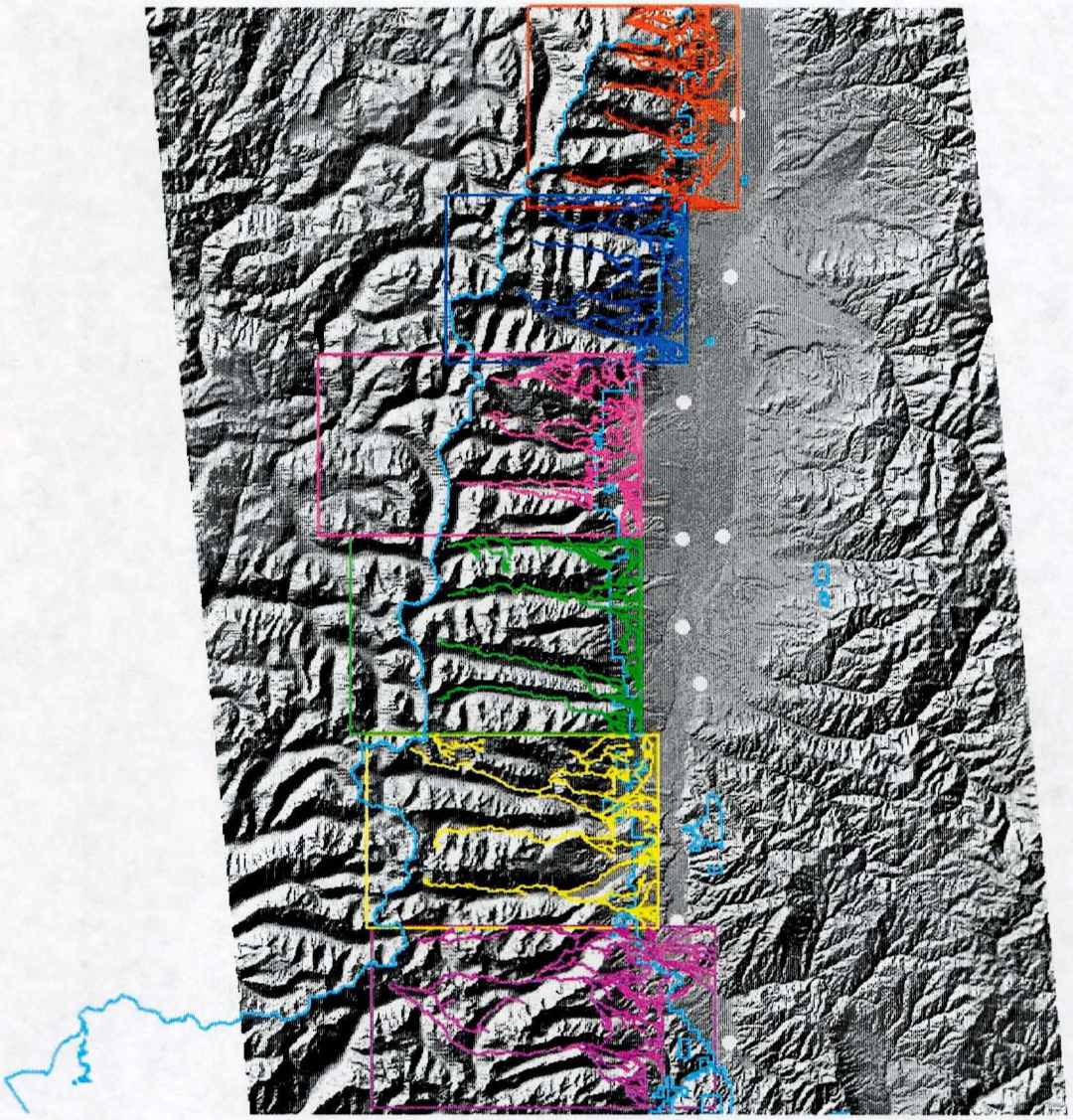
- FARSITE Fuel Model 15 : Upper subalpine shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 18 : Upper subalpine moderately dense to dense timber types
- FARSITE Fuel Model 21 : Lower subalpine grass and herbaceous vegetation types
- FARSITE Fuel Model 25 : Lower subalpine shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 28 : Lower subalpine moderately dense to dense timber types on southerly aspects
- FARSITE Fuel Model 30 : Lower subalpine moderately dense to dense timber types on northerly aspects
- FARSITE Fuel Model 31 : Mesic montane grass and herbaceous vegetation types
- FARSITE Fuel Model 35 : Mesic montane shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 38 : Mesic montane moderately dense to dense timber types on southerly aspects
- FARSITE Fuel Model 39 : Mesic montane moderately dense and dense ponderosa pine types
- FARSITE Fuel Model 40 : Mesic montane moderately dense to dense timber types on northerly aspects
- FARSITE Fuel Model 41 : Xeric montane and riparian grass and herbaceous vegetation types
- FARSITE Fuel Model 42 : Xeric montane shrub and herbaceous vegetation types
- FARSITE Fuel Model 45 : Xeric montane and riparian shrub and herbaceous vegetation, with some open timber types and regeneration units
- FARSITE Fuel Model 48 : Xeric montane and riparian moderately dense to dense timber types on southerly aspects
- FARSITE Fuel Model 49 : Xeric montane moderately dense and dense ponderosa pine types
- FARSITE Fuel Model 50 : Xeric montane and riparian moderately dense to dense timber types on northerly aspects

Canopy and other characteristics were assigned to each combination as well and were designed to represent the array of canopy conditions most useful for driving crown fire behavior in FARSITE as well as reduction of wind for modeling surface fire behavior. These include canopy cover or "CNCV" which is canopy cover in percent cover, stand height or "STHT", which is average overall vegetation height in feet, canopy base height or "CNBH" which is height to live crown in feet, and canopy bulk density or "CNBD", which is density of available crown fuel, in kilograms /m3.

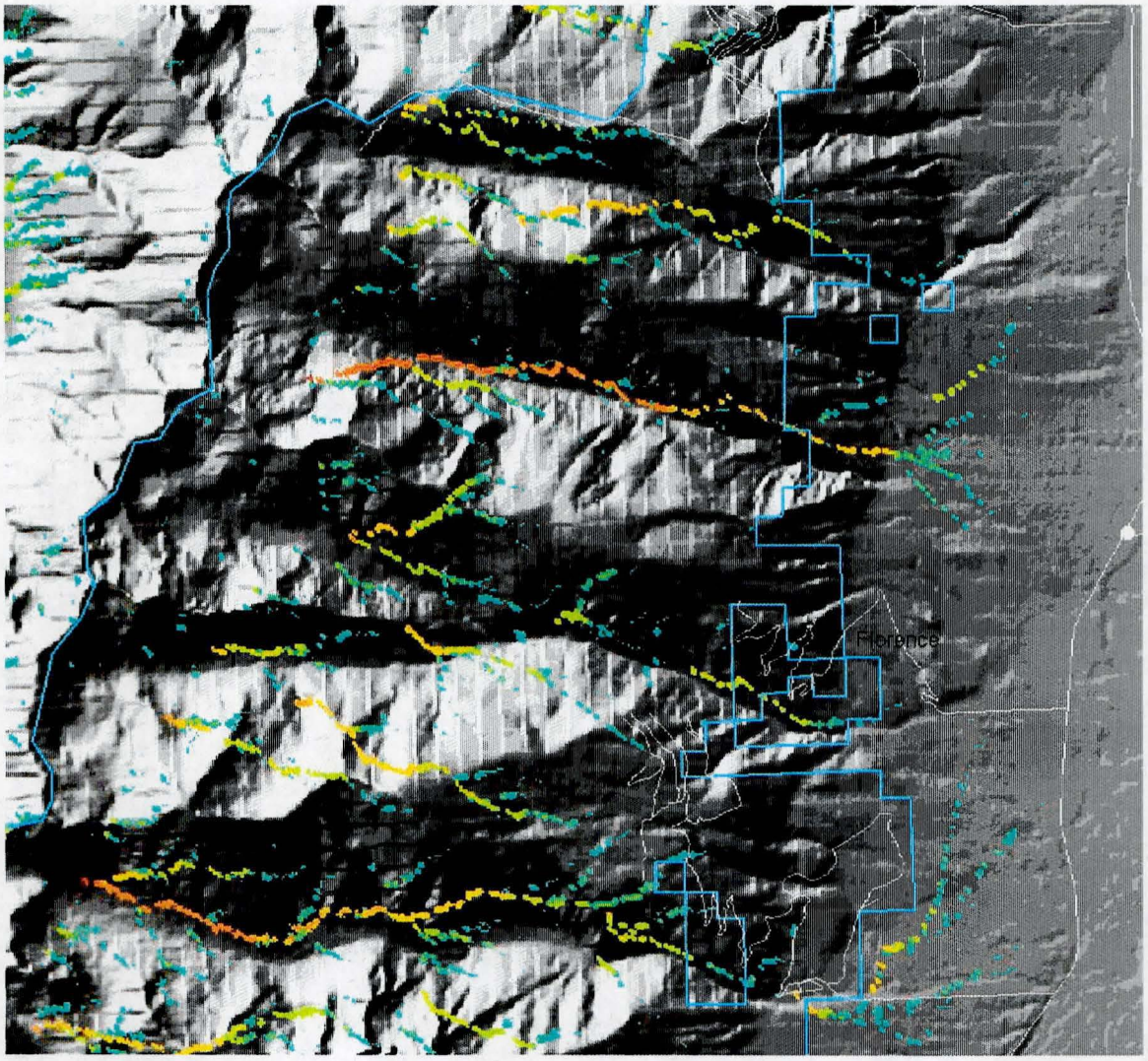
TASKS

1. Attend BEMRP meetings with Forest Service and University of Montana personnel.
2. Develop historical weather data necessary for the modeling environment (Fire Family Plus).
3. Compile, develop, and/or become familiar with the data layers required for use in FARSITE, FlamMap, and the Minimum Travel Time.
4. **Use the above models to map fire hazard and identify optimal fuel treatment patterns to mitigate fire spread into wildland-urban interface areas.**
5. Research reporting and presentation of model(s) methodology, output, and results.

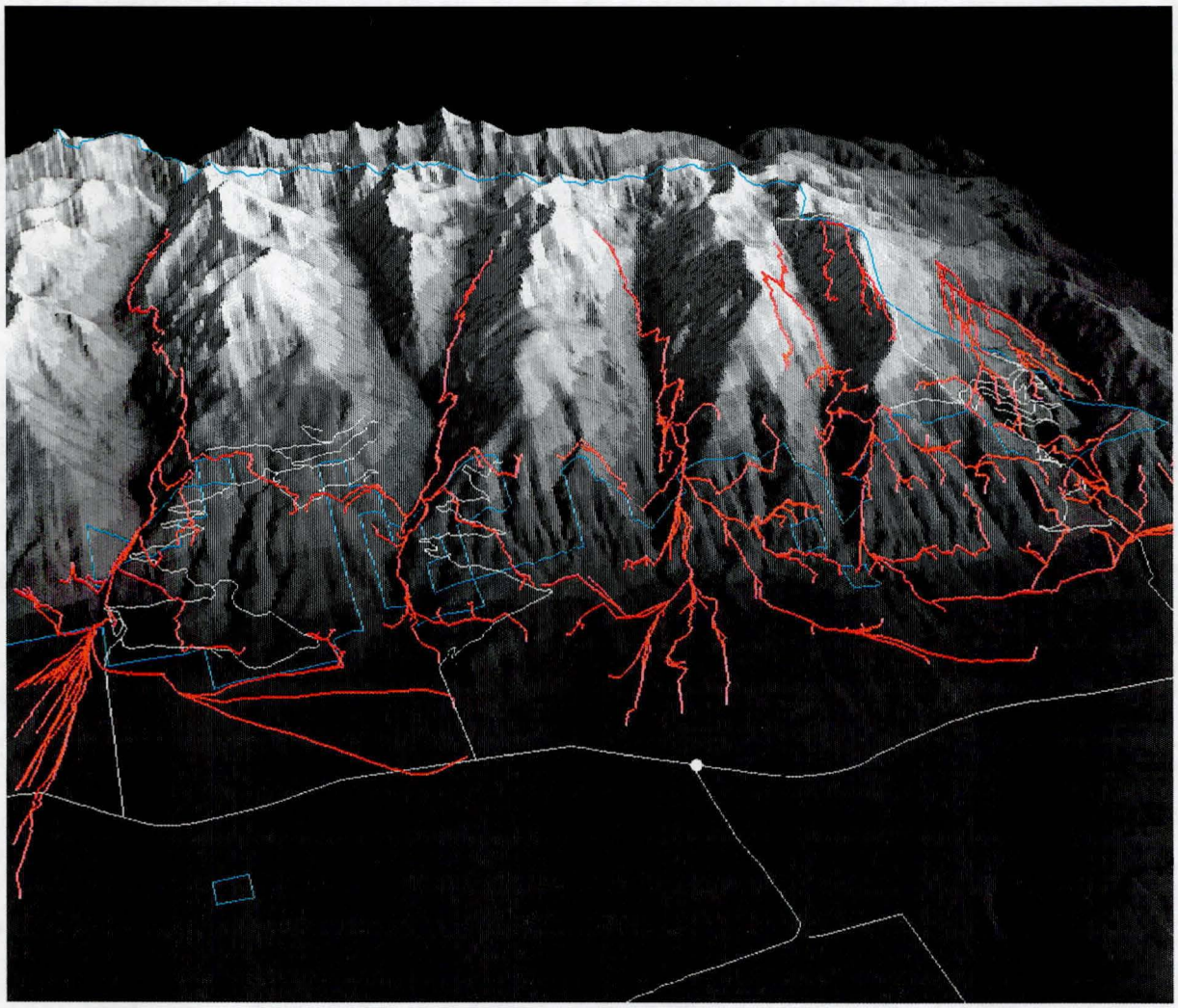
MINIMUM TRAVEL TIME SIMULATIONS
FOR THE
BITTERROOT ECOSYSTEM MANAGEMENT RESEARCH PROJECT



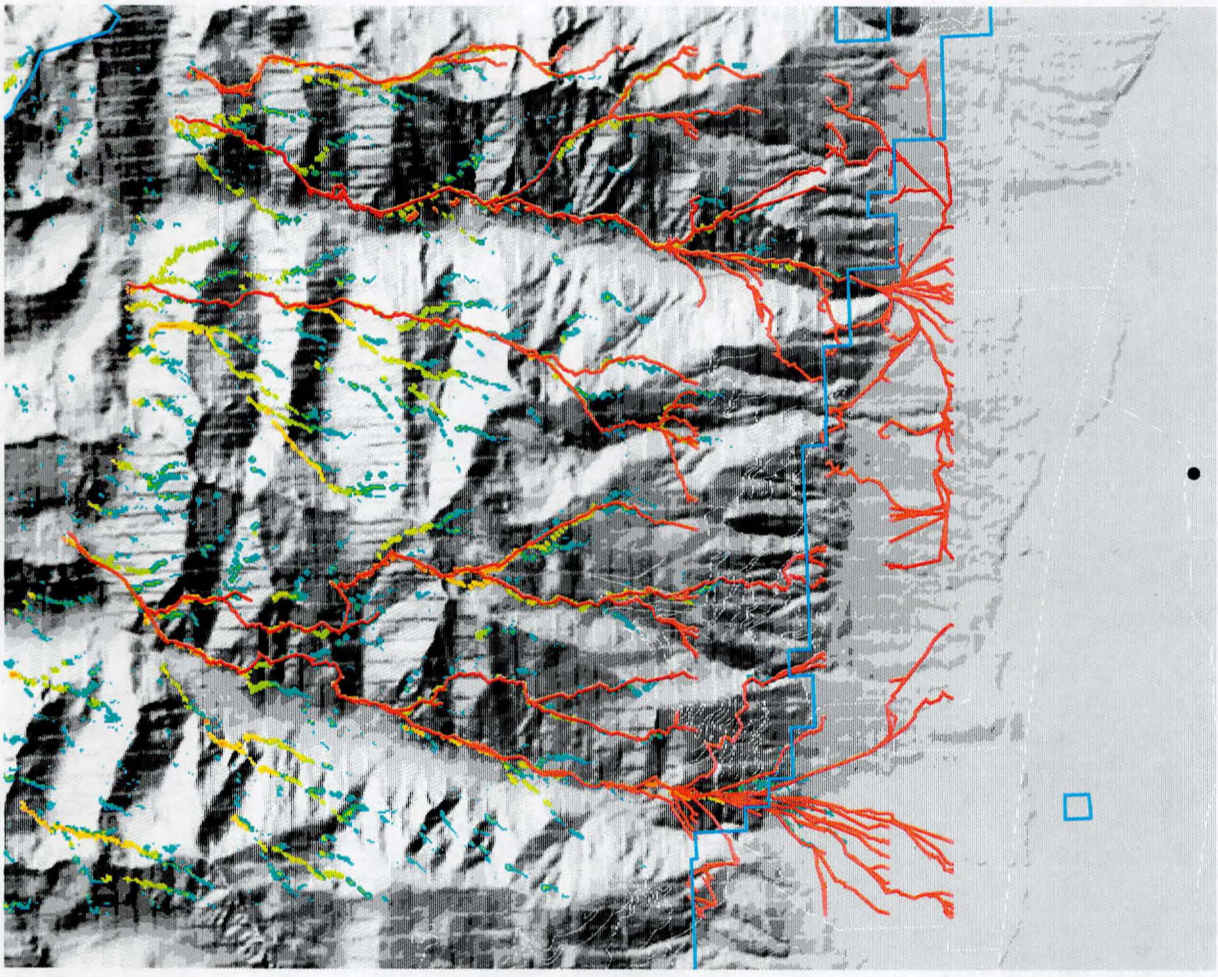
Modeling Compartments. MTT modeling compartments from north (top) to south (Florence, Stevensville, Victor, Hamilton, Darby, Conner)—six in all—overlaid with the Forest boundary (light blue), major cities (white dots), and a 30-meter shaded relief.



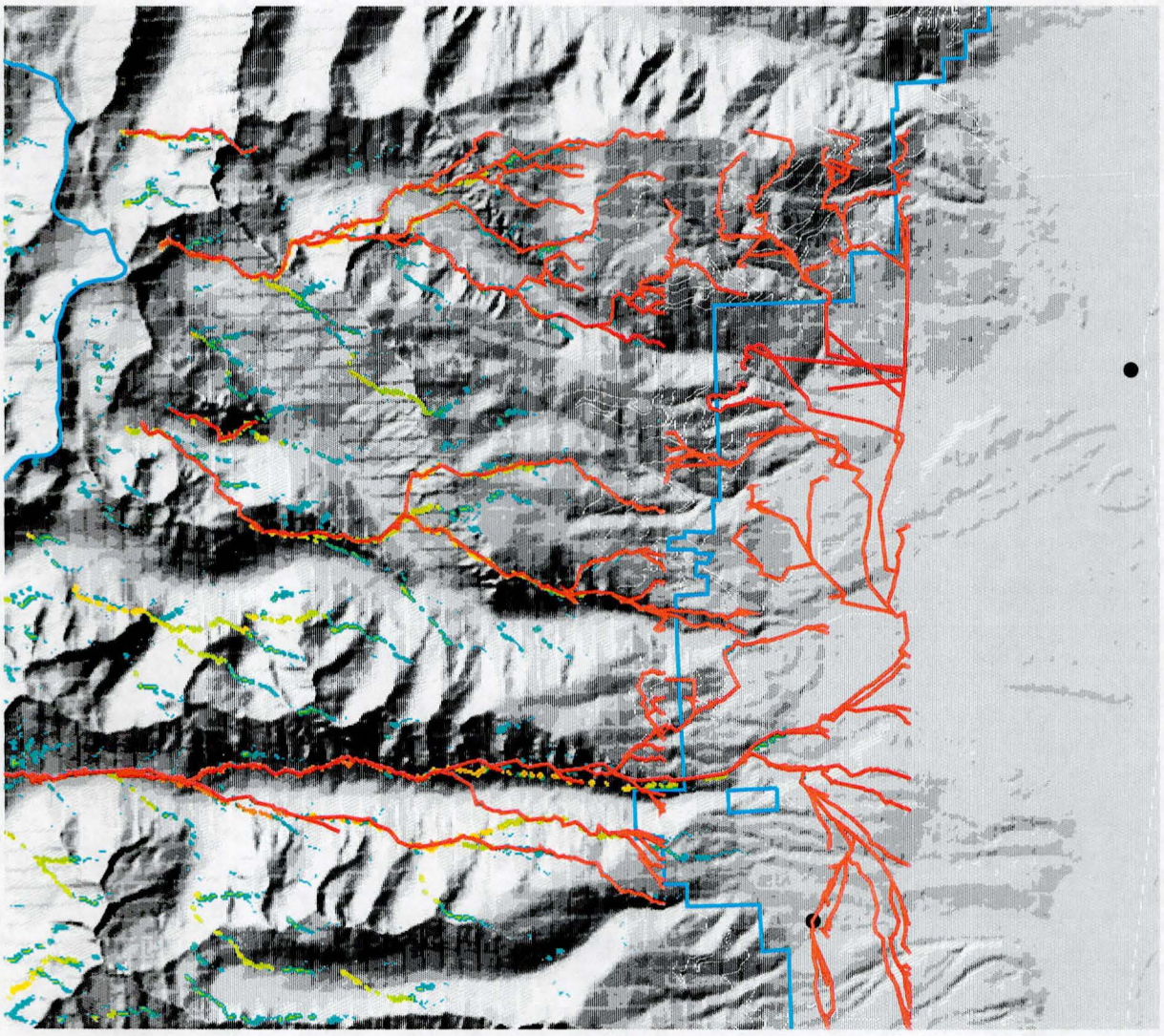
Compartment 1 (Florence). Influence pathways (raster output) delineated by importance (i.e., those paths that go on to burn the most acreage) by red (very high), orange (high), and green (moderate). Low values have been omitted. Overlays include the Forest boundary (blue), Florence (white dot to the east), and a shaded relief.



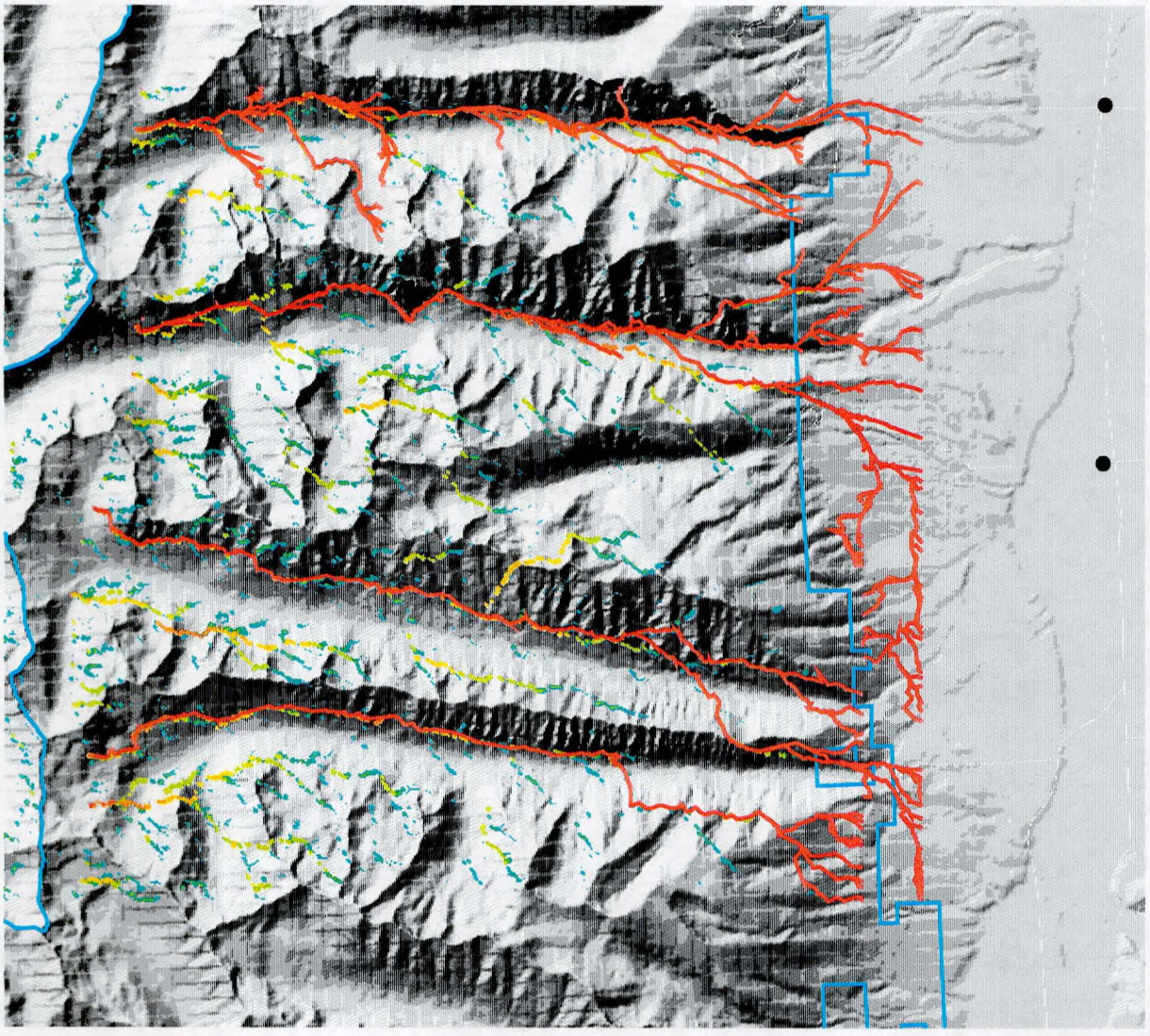
Compartment 1 (Florence). Minimum pathways (red) as calculated by the MTT algorithm and overlaid with the Forest boundary (blue), roads (white), Florence (white dot), and a 3-D shaded relief.



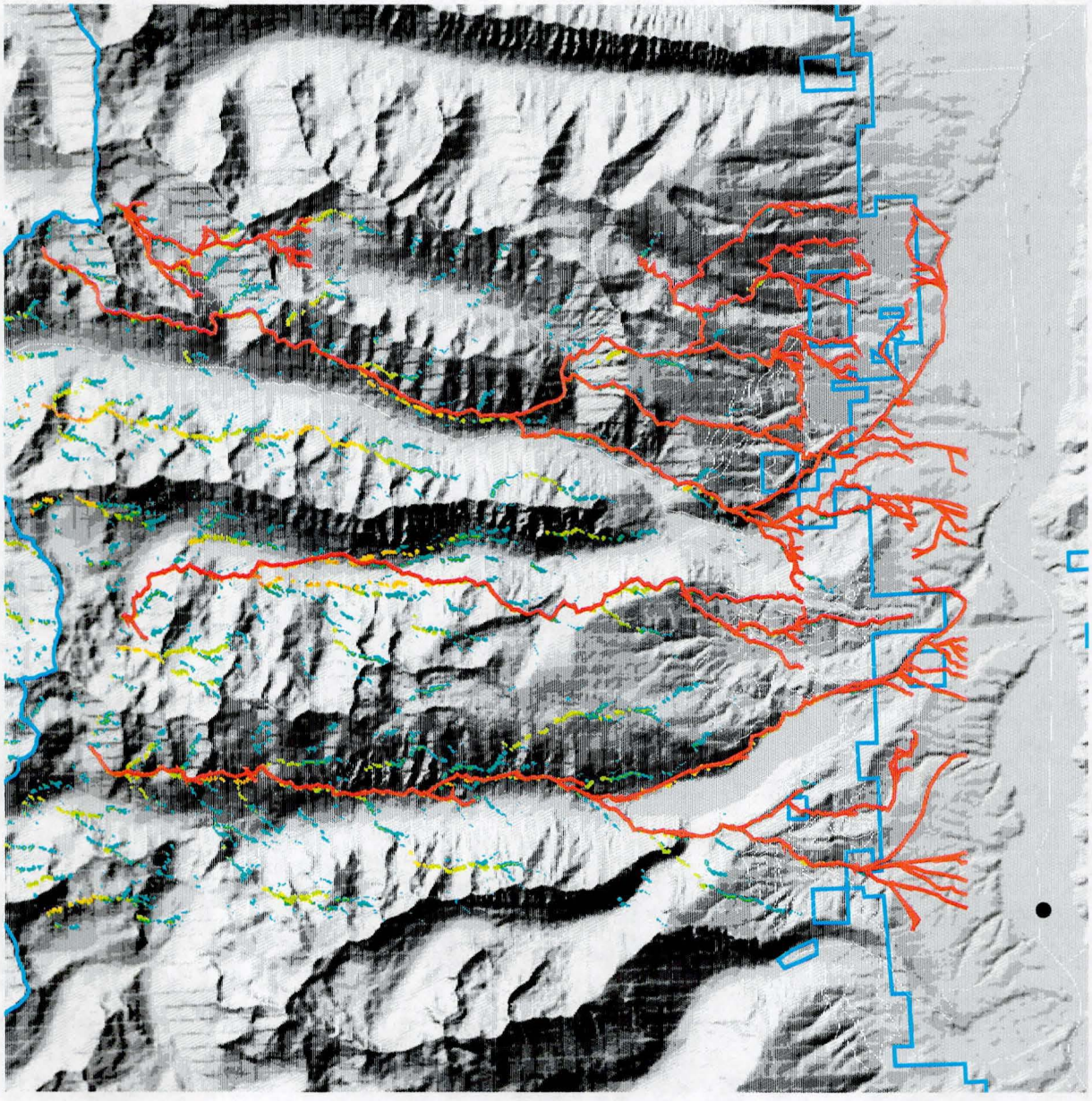
Compartment 2 (Stevensville). Minimum pathways (red) as calculated by the MTT. Influence pathways (raster output) delineated by importance (i.e., those paths that go on to burn the most acreage) by red (very high), orange (high), and green (moderate). Low values have been omitted. Overlays include the Forest boundary (blue), roads (white), Stevensville (black dot to the east), and a shaded relief.



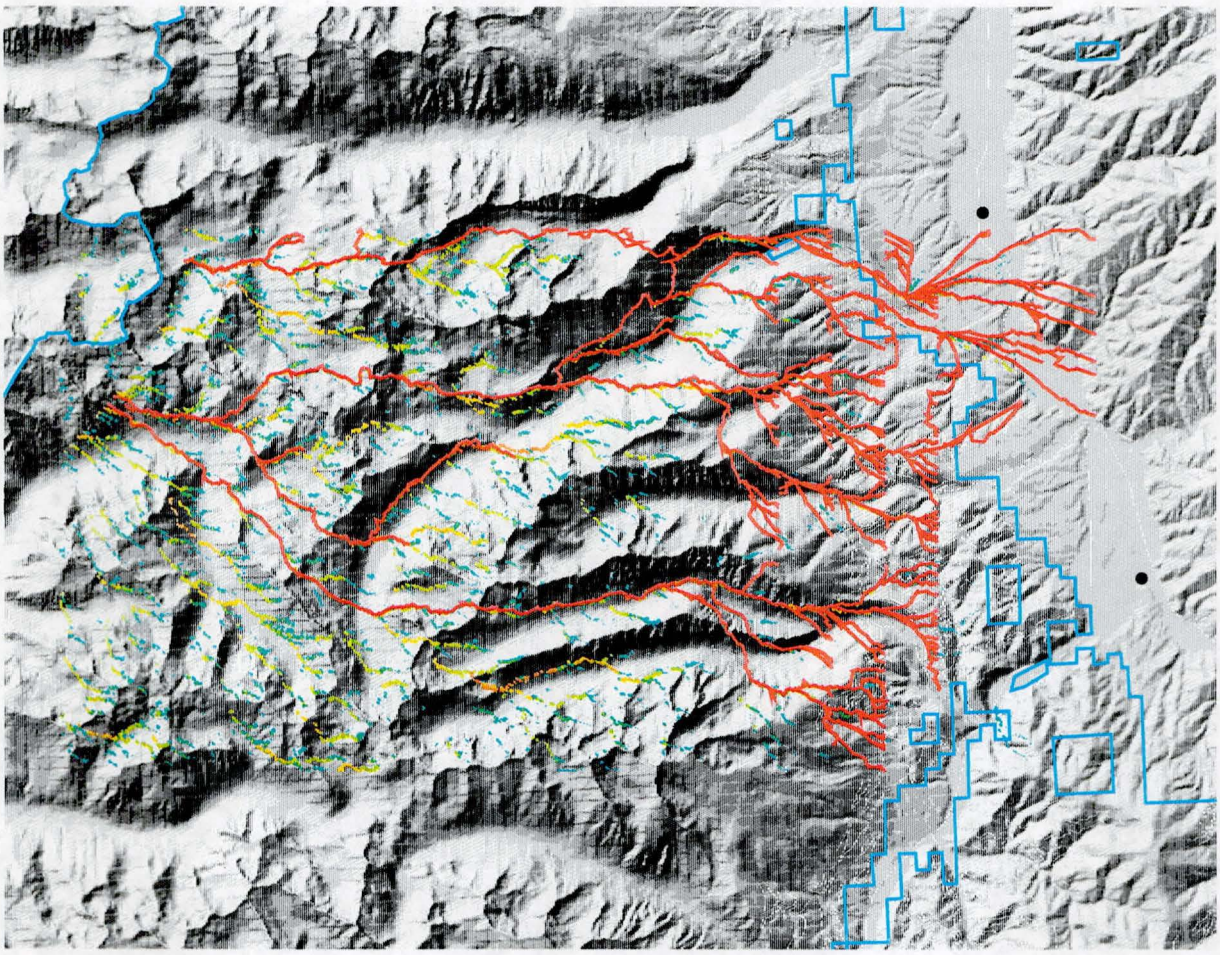
Compartment 3 (Victor). Minimum pathways (red) as calculated by the MTT. Influence pathways (raster output) delineated by importance (i.e., those paths that go on to burn the most acreage) by red (very high), orange (high), and green (moderate). Low values have been omitted. Overlays include the Forest boundary (blue), roads (white), Victor (NE), Pinesdale (SW), and a shaded relief.



Compartment 4 (Hamilton). Minimum pathways (red) as calculated by the MTT. Influence pathways (raster output) delineated by importance (i.e., those paths that go on to burn the most acreage) by red (very high), orange (high), and green (moderate). Low values have been omitted. Overlays include the Forest boundary (blue), roads (white), Hamilton (black dot to the east), Woodside (NE), and a shaded relief.



Compartment 5 (Darby). Minimum pathways (red) as calculated by the MTT. Influence pathways (raster output) delineated by importance (i.e., those paths that go on to burn the most acreage) by red (very high), orange (high), and green (moderate). Low values have been omitted. Overlays include the Forest boundary (blue), roads (white), Darby (black dot to the SE), and a shaded relief.



Compartment 6 (Conner). Minimum pathways (red) as calculated by the MTT. Influence pathways (raster output) delineated by importance (i.e., those paths that go on to burn the most acreage) by red (very high), orange (high), and green (moderate). Low values have been omitted. Overlays include the Forest boundary (blue), roads (white), Darby (north black dot), Conner (south), and a shaded relief.

TASKS

1. Attend BEMRP meetings with Forest Service and University of Montana personnel.

2. Develop historical weather data necessary for the modeling environment (Fire Family Plus).

3. Compile, develop, and/or become familiar with the data layers required for use in FARSITE, FlamMap, and the Minimum Travel Time.

4. Use the above models to map fire hazard and identify optimal fuel treatment patterns to mitigate fire spread into wildland-urban interface areas.

5. **Research reporting and presentation of model(s) methodology, output, and results.**

MINIMUM TRAVEL TIME SIMULATIONS - NARRATIVE

MTT Assumptions/Limitations

- Exact ignition point irrelevant; models large fire growth.
- Output only a reflection of the quality of the digital data, particularly the vegetation classification and the fuel model cross-walk.
- Displays large fire movement under target conditions (i.e., a 97th + percentile weather and wind event pushing fire east; it *only* shows routes of possible fire movement under this scenario, assuming a very broad fire front).
- Use in terms of conductivity of fuels; spotting is not modeled.

Treatment Considerations

- No exact or optimum treatment, but many good ones.
- Relative pattern of treatments more important than an absolute area.

The Process

FARSITE data

- Inputs include slope, aspect, elevation, fuel model, canopy cover, crown base height, crown bulk density, stand height.

Remote Automated Weather Station (RAWS) Retrieval

- Obtained RAWS information for Stevensville (3360 ft/11-year history), Smith Creek (5650 ft/3 years), and Deer Mountain (7283 ft/50 years).

Climatology Analysis in Fire Family Plus

- Based on climatology and fire associations (multi-fire days and large fire events), developed weather inputs (i.e., 1-hr (4%), 10-hr (5%), 100-hr (7%), live herb (50%), live woody (90%), 20-ft wind speed (25 mph), wind direction (270°), foliar moisture content (100%), and hourly weather and wind (cloud cover) streams (2 weeks from Aug. 2003).

Fire Ignition History

- Obtained Bitterroot NF ignition history (1970-2003); developed a density grid to aid in identifying a series of higher fire start areas. Created a line fire connecting these likely ignition areas 1-2 miles east of the Bitterroot Crest.

Fire Atlas

- Obtained Bitterroot NF stand aged-based fire history (1877-2003); analyzed fire shed, size, spread direction, location, and effect of the Bitterroot Crest and rocky east-west ridgelines.

FlamMap

- Ran simulation under weather parameters outlined above—an output is produced for *every* 30-meter pixel on the landscape. Output used by the MTT algorithm includes elliptical dimensions (a, b, c) and max spread direction (**Figure 1-4**).

MTT Modeling Compartments

- Partitioned the landscape into 6 compartments (Florence, Stevensville, Victor, Hamilton, Darby, Conner) based on the historical fire shed and transverse ridgelines, terminating them north to south on the leeward side of the east-west crests.

Minimum Travel Time

- Simulation output includes flow paths (**Figure 5**), influence pathways (**Figure 6**), and minimum pathways (**Figure 7**) for the entire study area (**Figure 8**).

Model Findings/Discussion Points

MTT Output

- Pathways generally follow valley bottoms or mid-slope where the connectivity is greatest, but rarely crest ridges and continue on down the adjoining drainages.
- Pathways may move up or down slopes in the Bitterroot drainages, but are typically truncated by ridgelines.
- Once fires reach the face, *multiple pathways develop* spreading laterally. Fires starting low to mid-slope on the Face and then spreading latterly and upslope is common in the fire record and evidenced recently by the Big Creek Fire (2003) and the Blodgett Canyon Fire (2000)

Fire History

- Based on the Forest's fire atlas and more recent fire events in the Bitterroot, fires infrequently start high and proceed down-slope to the Front. A primary cause of this may be the distribution of rocky ridgelines and the success of initial attack on high elevation fires. Other factors that possibly contribute include high fuel moistures, sheltering effect of the tree canopies, orientation of the terrain, and a short-duration fire season. **A more likely fire spread scenario is where fires initiate at low or mid-elevations along the Bitterroot Front, progress upslope and/or move laterally for several days or weeks, like the Blodgett Canyon Fire, before being impacted by a weather event that then pushes a broad fire front downslope to the east.**

Limited Treatment Options

- The treatable landscape is severely constrained as a long linear geographic feature – bounded by private ownership on the east and the Wilderness boundary on the west. Moreover, grass and brush areas in lower elevations offer limited durable benefit from treatment; further narrowing the treatable landscape to lower-elevation zones characterized by ponderosa pine and mixed conifer forests where fuel treatment prescriptions are ecologically consistent. Couple the fuel and ecological constraints with accessibility, public ownership and concerns, hydrology, etc. and **this means that along the west side of the Bitterroot Valley very few options exist for treatment. With so few choices, and such a clear picture of the direction that fire movement causes problems, optimization is probably not necessary or fruitful – essentially all lands that can be treated should be treated.**

  Although fire use or prescribed fire (Bob Marshall) at higher elevations is an improved option over solely targeting the Front, a treatment strategy along the Front that identifies those areas where fire use could potentially "leak out" is worth considering. These treatments would serve a duel purpose, not only for enabling fire use, but fires started along the Front or mid-slope could potentially be altered as well. **However, no fuel treatment will stop fires and should not be thought of as a means to stop them. Fire suppression is just not effective under extreme weather conditions and against large fires. Fuel treatments should be considered a means to slow fire spread, reduce the severity, and buy time for changes in weather to change behavior and enable suppression success.**

Fire Use

- Based on the climatology, fire associations, and barren areas on the Forest, a fire use program in these higher elevations, given time, would create natural barriers to mitigate the threat of a larger fire proceeding eastward. These previous fire areas may have more of an effect on mitigating fire spread and intensity than treatments on the Front because (1) the prior fire would be closer to the ignition source and (2) wildfires would potentially encounter successive previous fire areas, rather than a narrow treatment band along the Front. By suppressing smaller fires between the wilderness boundary and the Bitterroot Crest, we are selecting for larger fire(s), which compromise the effectiveness of landscape fuel treatments on the Front. Indeed, the risk of not introducing wildland fire use may be greater than the risk of a large down-canyon fire impacting the Front Range.

MINIMUM TRAVEL TIME SIMULATIONS - GRAPHICS

Inputs

DEM (slope, aspect, elevation)
Fuel Model
Canopy Characteristics
Fuel Moisture
Ignition *line* to the west
97+ percentile weather and wind (RAWS/Fire Family Plus)
Elliptical dimensions and maximum spread at *each* cell (FlamMap)

MTT Schematic

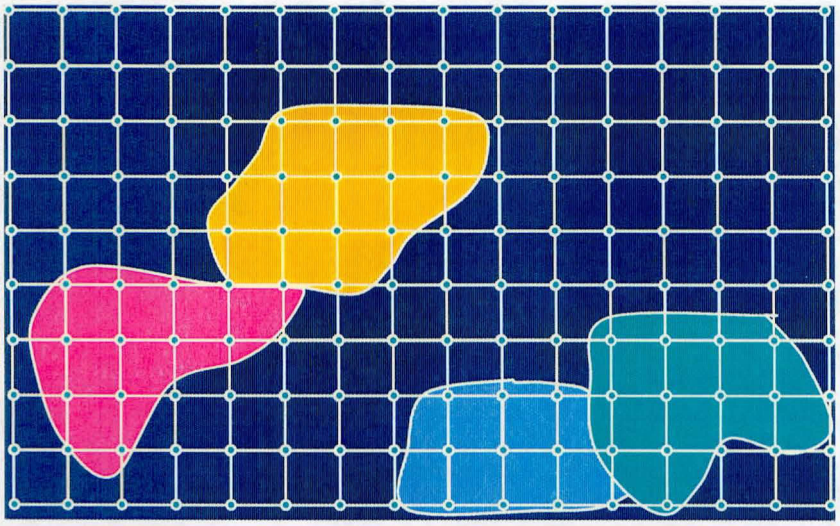


Figure 1. Rectangular lattice, draped on fuels, weather, and topography.

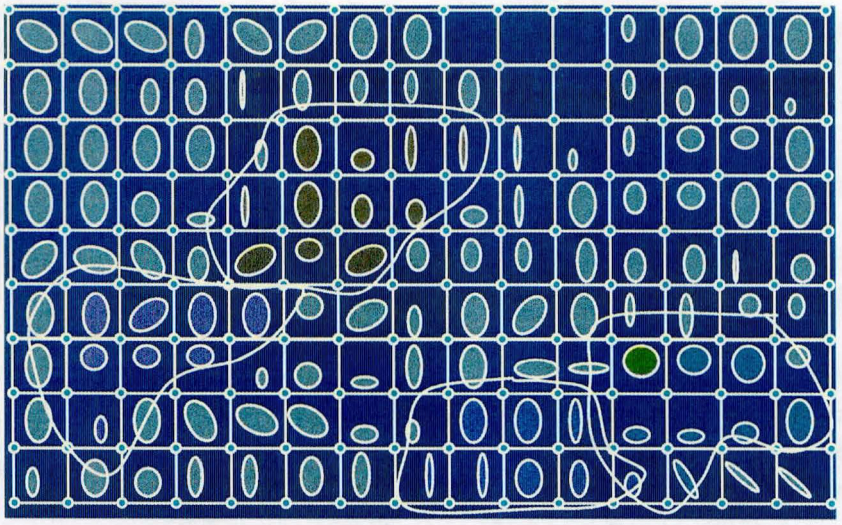


Figure 2. Each cell contains 2-D spread rates (elliptical) and a max spread direction.

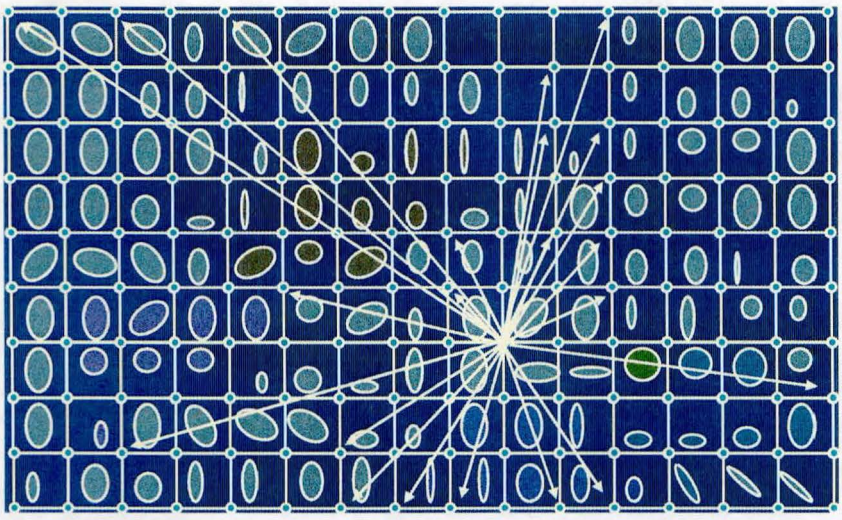


Figure 3. Search for minimum travel time among all nodes.

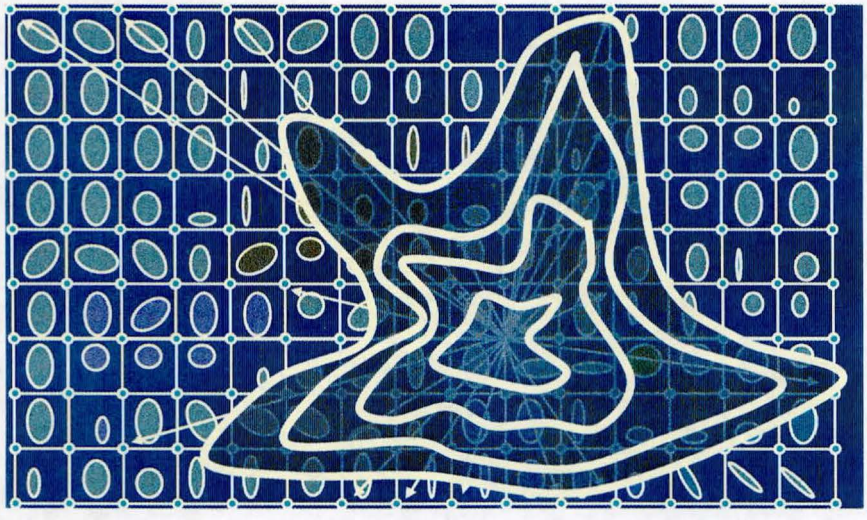


Figure 4. Nearly identical growth patterns as Huygen's principle (FARSITE); processing time 4-12+ times faster.

Figure 5. Example of flow paths (red) from modeling compartment 1 (Florence).

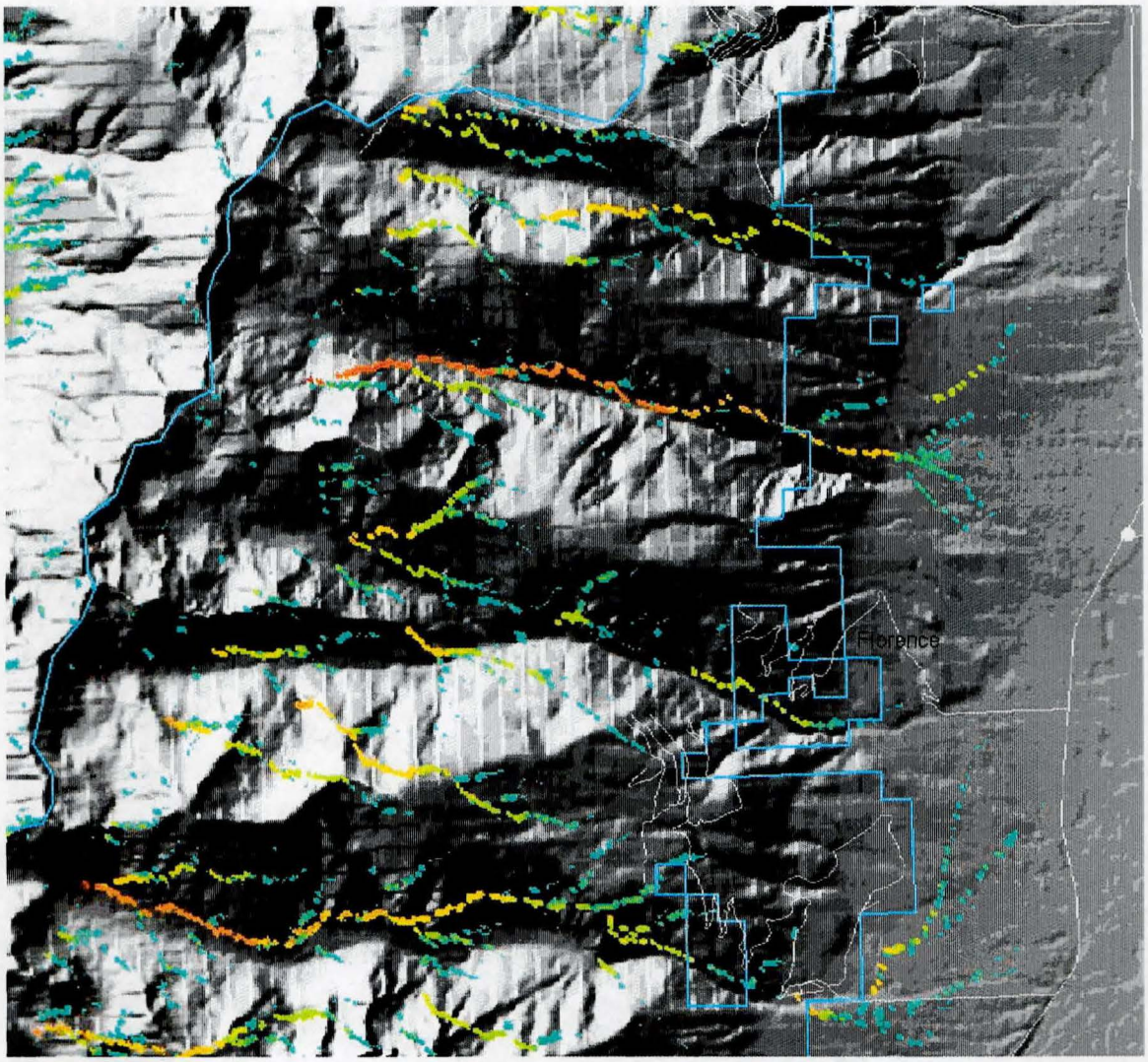


Figure 6. Influence pathways (raster output) delineated by importance (i.e., those paths that go on to burn the most acreage) by red (very high), orange (high), to green (moderate). Low values have been omitted. The white dot to the east is Florence.

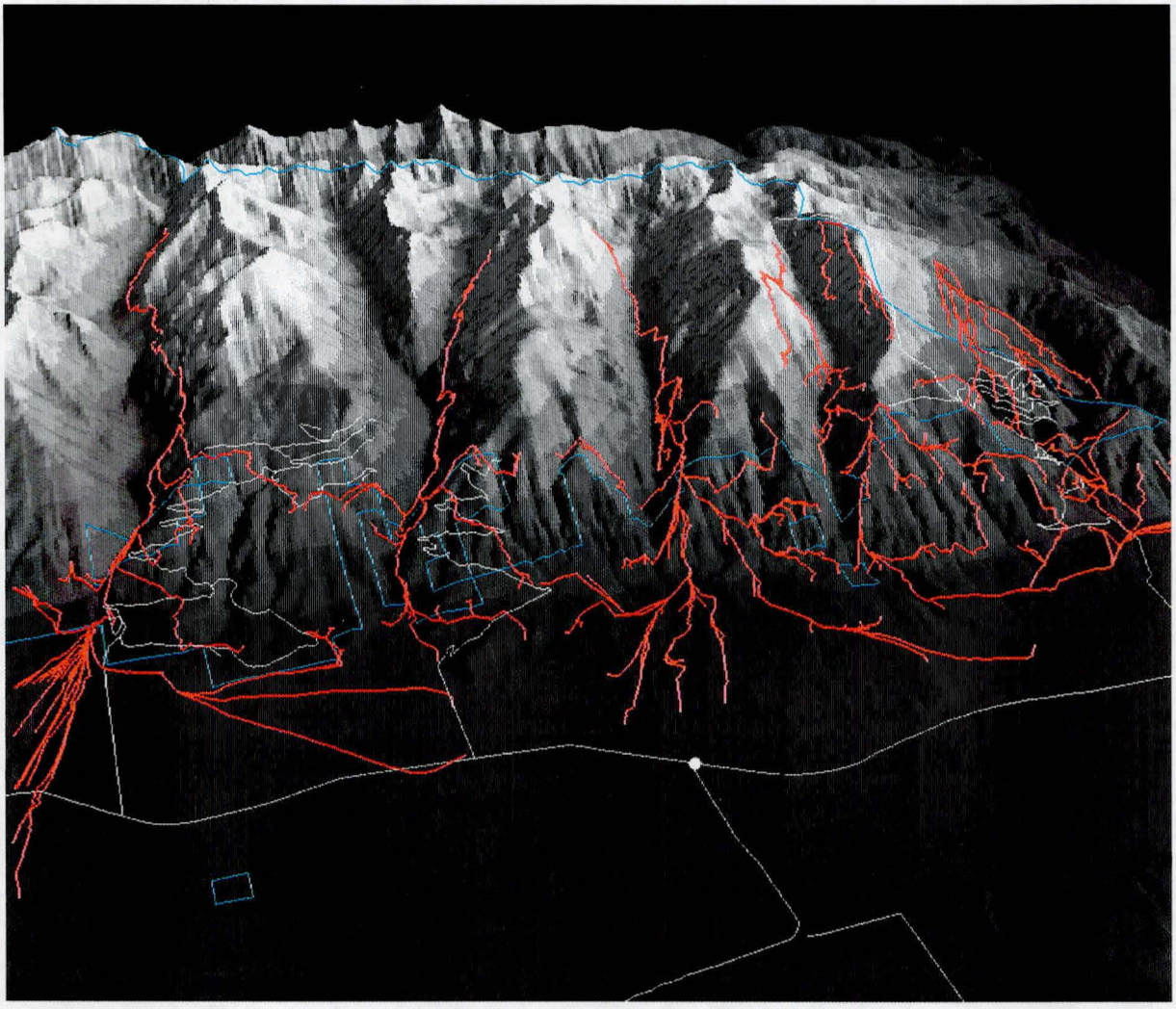


Figure 7. Minimum pathways (red) as calculated by the MTT algorithm and overlaid with the Forest boundary (blue), roads (white), and Florence (white dot).

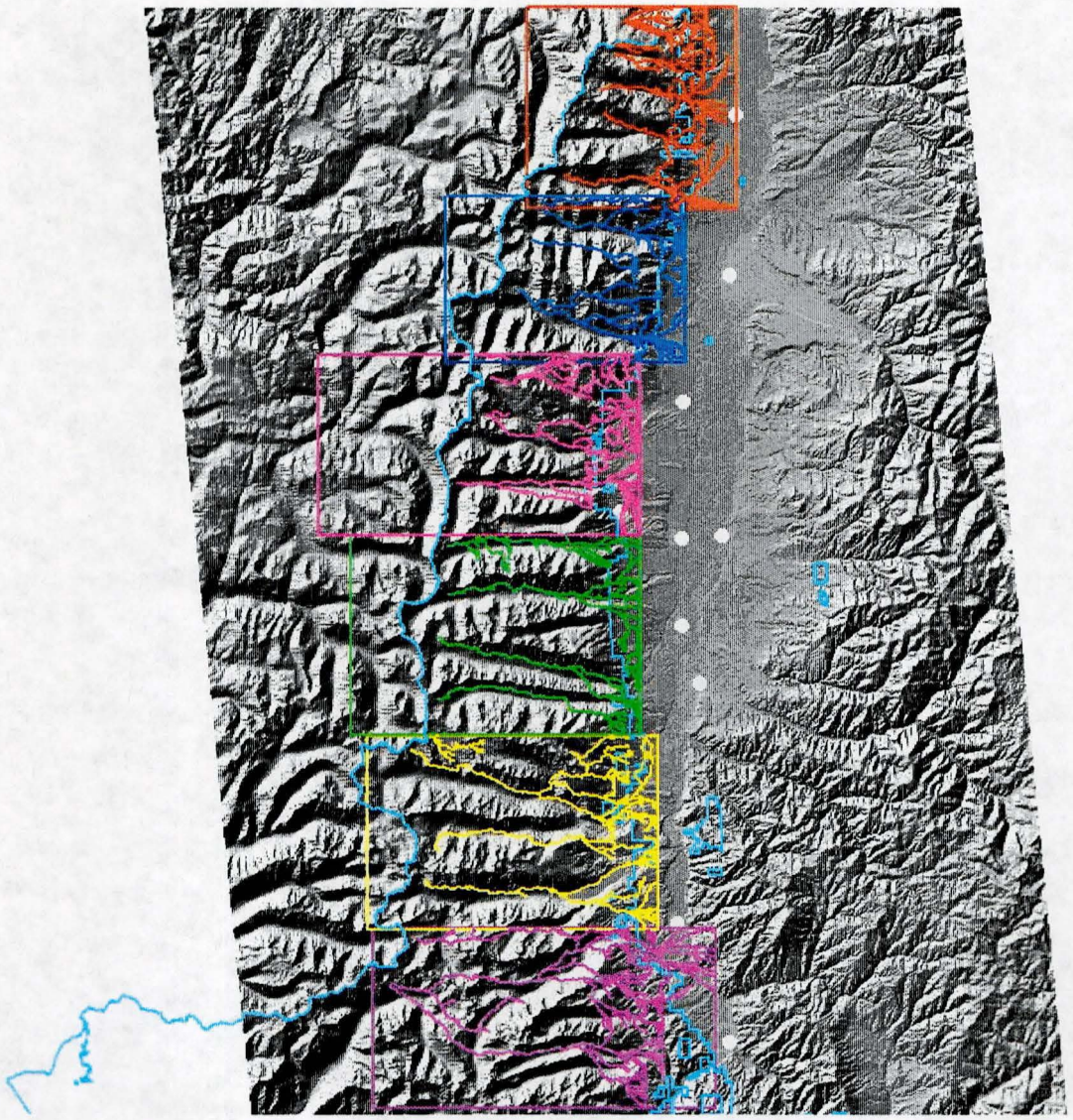


Figure 8. MTT output for the entire Bitterroot Front. Minimum pathways colored by modeling compartment and overlaid with the Forest boundary (light blue) and major cities (white dots).

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